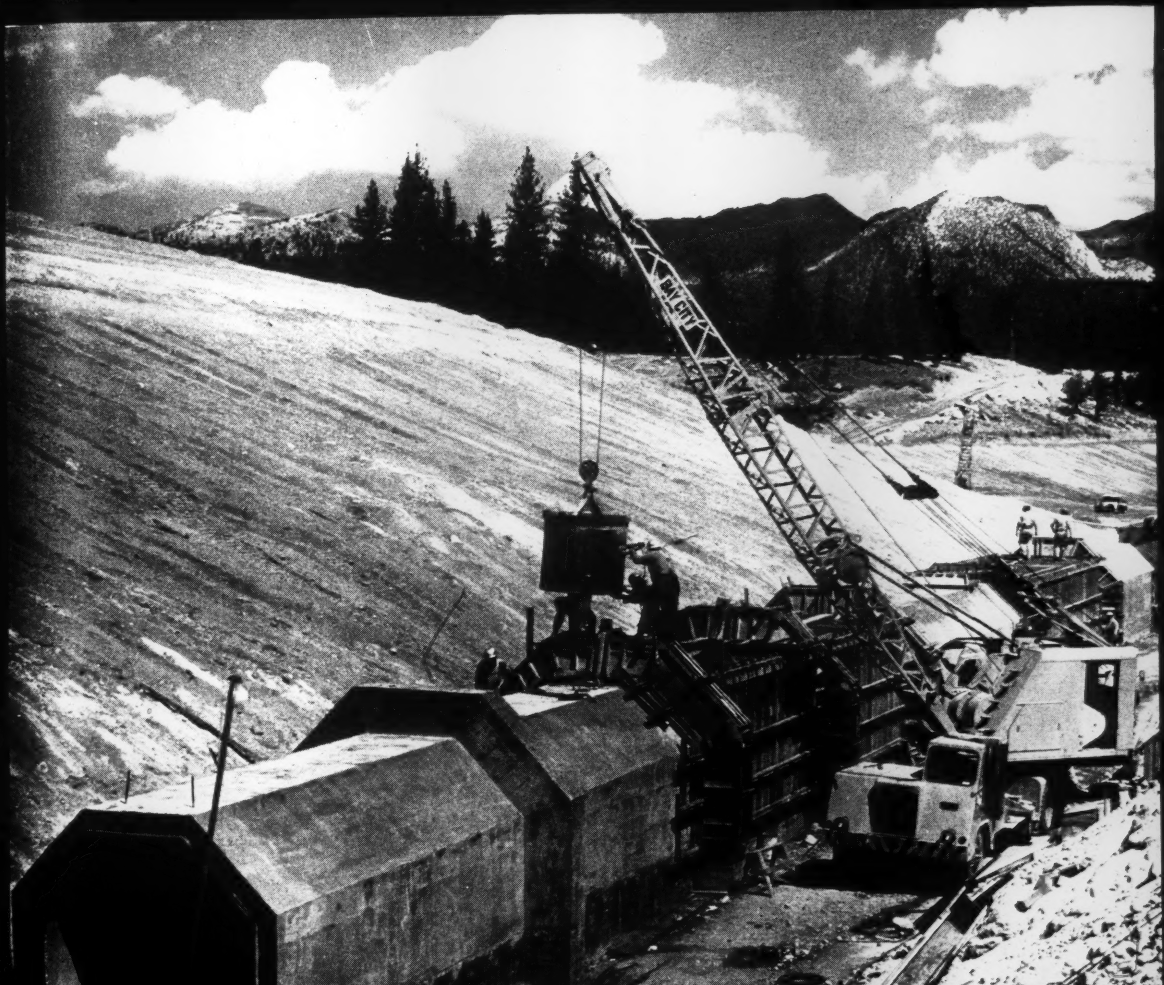
CIVIL ENGINEERING

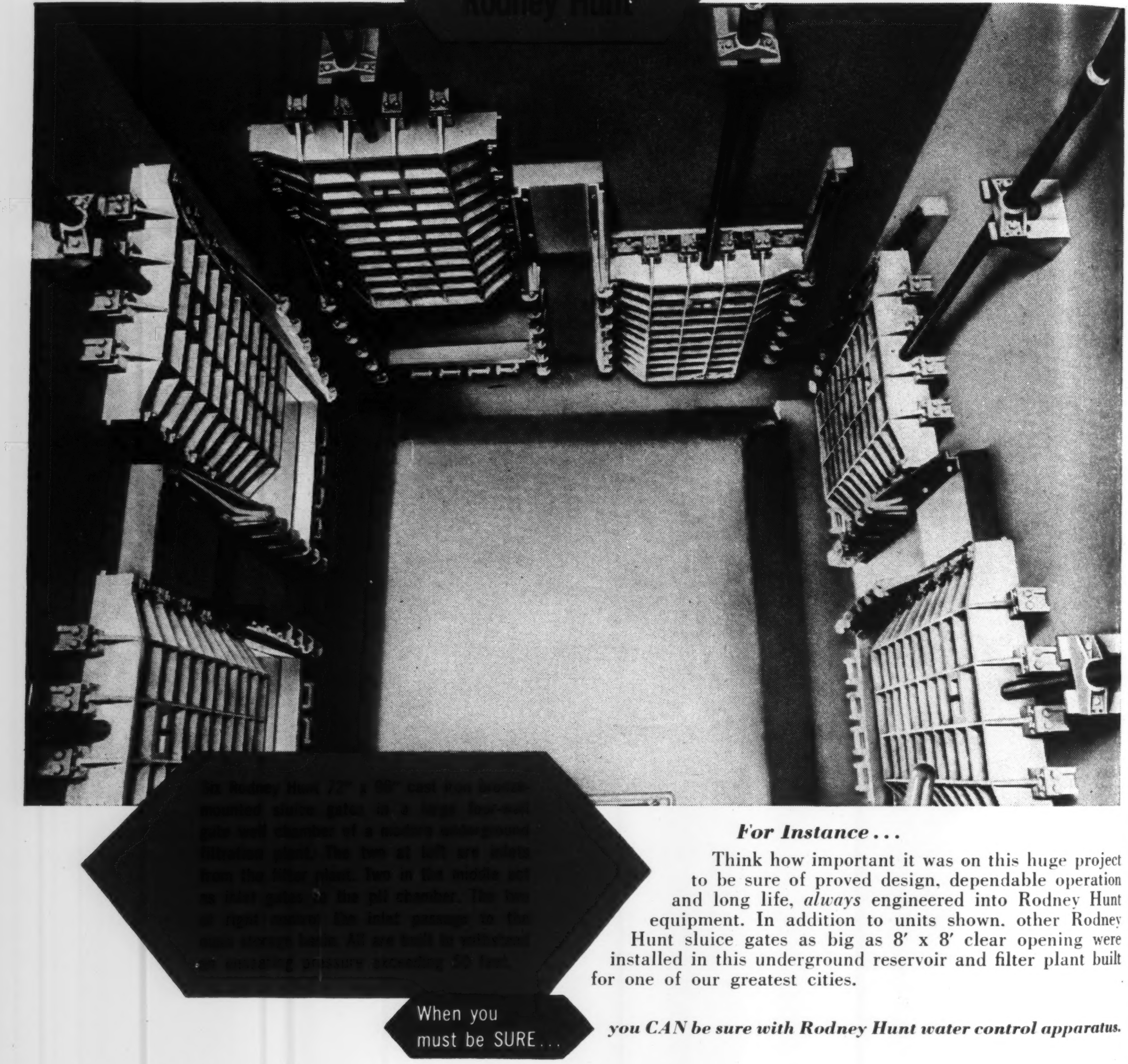


AMERICAN SOCIETY OF CIVIL ENGINEERS
FOUNDED 1852

See article on VERMILION VALLEY DAM by R. W. Spencer

When you
must be SURE . . .

specify
Rodney Hunt



Six Rodney Hunt 72" x 96" cast iron bronze-mounted sluice gates in a large four-way gate well chamber of a modern underground filtration plant. The two at left are inlets from the filter plant. Two in the middle act as inlet gates to the pH chamber. The two at right control the inlet passage to the open storage basin. All are built to withstand an operating pressure exceeding 50 feet.

For Instance . . .

Think how important it was on this huge project to be sure of proved design, dependable operation and long life, *always* engineered into Rodney Hunt equipment. In addition to units shown, other Rodney Hunt sluice gates as big as 8′ x 8′ clear opening were installed in this underground reservoir and filter plant built for one of our greatest cities.

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throughout the United States

CIVIL ENGINEERING

MARCH 1955
VOL. 25 • NO. 3

THE MAGAZINE OF ENGINEERED CONSTRUCTION

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...that pay off in greater strength, easier fabrication, high corrosion resistance and lower costs

SOMETHING new and important has been happening to bridge structures. Improved design, improved fabrication techniques, improved erection methods, and lower costs—all made possible by increasing use of *stronger, more durable steels.*

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A number of bridges, both large and small, have already been constructed with these high strength steels. In many of the most important bridges now being erected or projected for the future, these superior steels are being used or are specified. And for good reason.

All these famous "steels that do more" have higher yield points than structural silicon steel in thicknesses up to and including 1½". All have at least twice the atmospheric corrosion resistance. All, regardless of thickness, have greater ductility.

As a result, their use in structural members makes it possible for the designer to obtain greater strength with no increase in weight, or to reduce weight without any sacrifice in strength. And always, to ensure greater durability.

Maximum results can be obtained from these steels by taking advantage of their specific characteristics. For example, USS MAN-TEN Steel is intended primarily for use in structural members of riveted and bolted bridges requiring high strength with atmospheric corrosion resistance equal to that of copper steel.

While USS TRI-TEN "E" Steel can also be used for riveted bridges, it is particularly applicable where *weldability* is a primary consideration, and where structural members must withstand moderately severe impacts in low temperature service. This steel combines high strength and unusual toughness with atmospheric corrosion resistance equal to that of copper steel.

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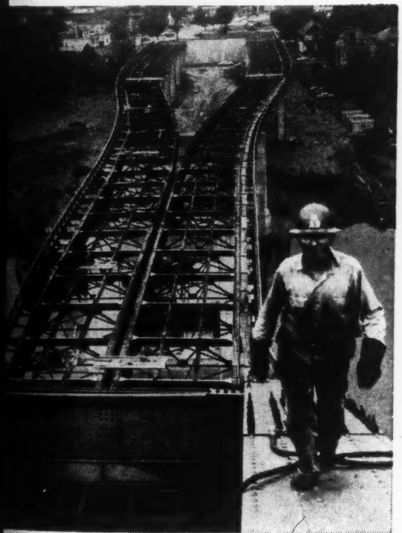

← **New 9th Street Bridge at Wheeling, West Virginia**

Now nearing completion, the new Ohio River crossing illustrated here is a typical example of the growing use of USS High Strength Steels in present-day bridge construction.

Owner: State of West Virginia
Consulting Engineers: Howard, Needles, Tammen & Bergendoff
Kansas City, Missouri

USS MAN-TEN Steel spans fabricated and erected by American Bridge Division of United States Steel.

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USS HIGH STRENGTH STEELS

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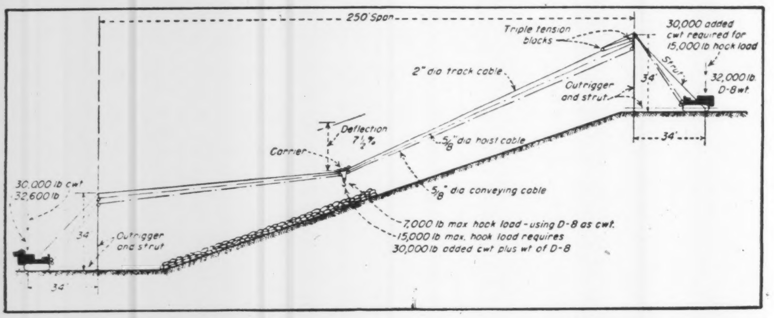
UNITED STATES STEEL

NEWS OF ENGINEERS

Edwin B. Foster announces the opening of a consulting office for the practice of civil and structural engineering at 702 South Orange Grove Avenue, Los Angeles 36. Recently Mr. Foster was supervising engineer for Knappen-Tippetts-Abbett-McCarthy, Engineers, in Rangoon, Burma. During this period he was also technical adviser to the Mingaladon Aerodrome Construction Committee in Burma on construction of a large airport and its terminal facilities.

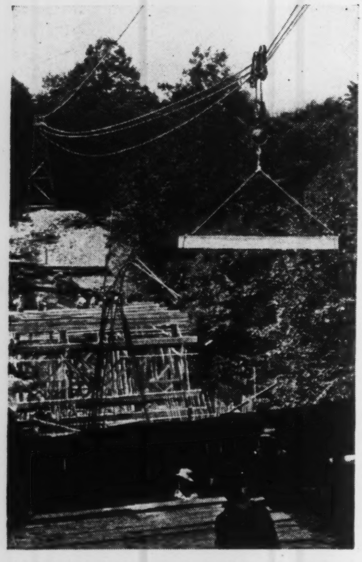
Ernest A. Fort, formerly assistant director of the Miami, Fla., Public Service Department, has been promoted to director.

Alexander M. McKean, of Jackson Heights, N.Y., retired on January 27 from his position as chief engineer of marketing and director of safety for the American Oil Co. of New York City. Mr. McKean has been with American Oil since 1919.



Portable cableway, strung between crawler tractor-mounted booms, served one contractor well in placing a rock mat on the slope of a river bank. Tautline moved with ease, despite extra counterweights needed for heavy hook loads.

You Can Use A Small Cableway*



Materials for highway bridge in Turkey Run Indiana State Park were spotted with a tautline on wooden A-frame towers, 40-ft. high. Cableway, concrete mixer and small sawmill were the only power equipment used.

* This is a brief adaptation of a 4-page article on small cableways recently published in a leading construction magazine. Reprints are available from Sauerman Bros., Inc.

. . . to meet practically any situation—temporary, semi-permanent, permanent—handling materials in remote areas, dangerous locations, across natural barriers or on construction sites covering many acres.

Highway Bridge in Indiana—All material for this 250-ft. concrete structure was transported by a Sauerman 2-ton tautline. The cableway spanned 460 ft. across a deep ravine.

Kansas River Dam—A power company uses a small Sauerman cableway to transport materials for repair and maintenance. The unit spans the river over the top of the dam. Workmen ride a special cage to work over the dam and raise or lower flash boards used to control height of the reservoir.

Power Plant for a Kentucky Dam—100,000 tons of Government furnished aggregate were delivered to the opposite bank, 1000 ft. away. A belt conveyor, supported by adequate suspension cables, would have been too expensive. Truck delivery would have entailed a long haul and construction of roads. A 4-ton Sauerman cableway was installed. From the loading point 280 ft. above the building site, loading buckets moved by gravity at 1200 fpm. to the batch plant across the river.

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Mace H. Bell, who has served the American Institute of Steel Construction since 1950 as assistant to the director of engineering, will be chief supervisor of the district engineers in the Institute's reorganization of the engineering department. Mr. Bell has been with AISC since 1936 and has been district engineer in New Orleans, St. Louis and, more recently, New York. In the new program designed to provide more comprehensive assistance to its members **Theodore R. Higgins,** director of engineering since 1945, will be director of engineering and research and **Eugene W. Gradt,** district engineer in Syracuse, N.Y., will be his assistant. **Edward R. Estes, Jr.,** assistant professor of applied mathematics at the University of Virginia, will remain as research engineer. The latter two will join the New York staff. Former district engineers now promoted to regional engineers are **Charles M. Corbit, Jr.,** Los Angeles; **Robert B. Reilly,** Dallas; and **H. J. Stetina,** Philadelphia.

Four ASCE members will make up a board of engineering consultants to assist in the St. Lawrence Seaway project. They are **Clarence E. Blee,** chief engineer for TVA, **Edward M. Fucik,** vice-president of the Harza Engineering Co. of Chicago, **Charles M. Wellons,** consulting engineer of Pittsburgh, Pa., and **Frank W. Edwards,** manager of the Chicago office of Stanley Engineering Co. Mr. Blee, with TVA for twenty years, will be consultant on deep-draft navigation channel construction. Mr. Edwards, a hydraulic engineering specialist on projects in the West and Midwest and chief of the hydraulic section in the design of the Third Locks Project on the Panama Canal, will be consultant on hydraulic problems. Mr. Wellons, has had wide experience as an electric utilities and government locks and dams constructor.

Curtis A. Nelson became director of the Atomic Energy Commission's Inspection Division at the Savannah River Operations Office (near Aiken, S.C.) on February 1. Until recently manager of the Savannah River Office, Mr. Nelson has had more than ten years active duty with the Army and holds a reserve commission as Colonel in the Corps of Engineers. He will be replaced by **Robert C. Blair** who has been deputy manager in the Savannah River office for the past four years. Mr. Blair joined the Military Application Division of AEC in 1949, and was transferred to Savannah River in 1950.

W. Leighton Collins, professor in the Department of Theoretical and Applied Mechanics at the University of Illinois, is the new secretary of the American Society for Engineering Education.

[redacted]

Howard K. Preston, professor and head of the University of Delaware's Department of Theoretical and Applied Mechanics, retired on January 31. Professor Preston has been on the faculty of the university for over thirty years. He graduated from Lafayette College in 1909 and taught there before going to the University of Delaware. In 1920 he became full professor and was head of the department in 1928.

R. E. Heartz

Richard E. Heartz, of Montreal, will take office in May as president of the Engineering Institute of Canada. Long active in Institute affairs, Mr. Heartz has been successively member of the council, treasurer and chairman of the Montreal Branch. A 1917 graduate of McGill University, he has served the Shawinigan Engineering Company, Ltd., and its parent, the Shawinigan Water and Power Company, since 1920. Mr. Heartz became vice-president and chief engineer in 1947 and has been president since 1952.

Arthur T. Larned, Charles C. Bonin, and Alexander C. Clogher, of Ebasco Services Inc., have been promoted. Mr. Larned, with the company since 1912 and chief civil engineer since 1933, has been made consulting civil engineer. Mr. Bonin, who takes his place as chief civil engineer, joined the company in 1938. Since then he has been hydraulic engineer, investigator and, most recently, project engineer of dam work in Japan, particularly the Kamishiiba Arch Dam on Kyushu Island. Mr. Clogher, new associate consulting engineer, has been with Ebasco since 1909, and has held the positions of hydraulic engineer, chief civil engineer, general engineer, and, since 1940, consulting civil engineer.

James A. McCarthy, professor of civil engineering, University of Notre Dame, has been elected chairman of the Indiana State Board of Registration for Professional Engineers and Land Surveyors for 1955.

George P. Fernandez, assistant county engineer of Shelby County, Ohio, with headquarters at Sidney, has been made a partner of the Sidney firm of F. E. Freytag. Mr. Fernandez is a registered engineer and surveyor.

(*Continued on page 25*)

JOB AFTER JOB, FRANKI FOUNDATIONS
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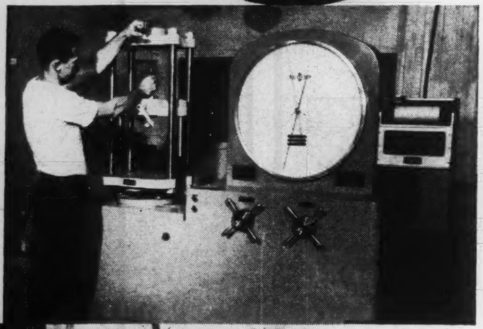
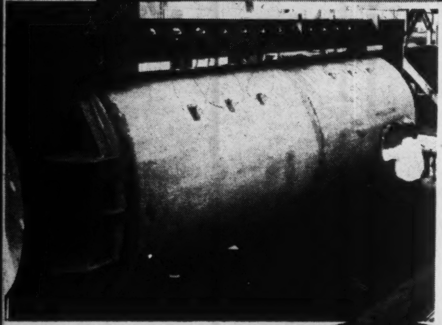
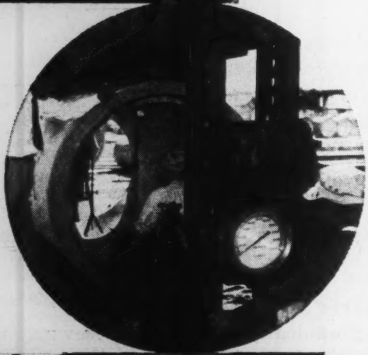
Standard 6"x 12" test cylinders are made from the same batch of concrete as the pipe, cured with the pipe in the same steam box and are subjected to compression tests.



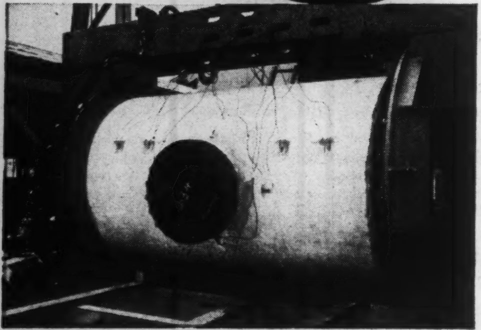
Steel reinforcement rods are tested to determine their physical properties. Stress-strain diagram may be plotted on recorder at right.



Completed pipe sections receiving hydrostatic test. Water pressure is increased until ultimate failure of the pipe section; research engineer makes periodic examinations as pressure goes up.



Resistance to external loadings is determined by careful checking as pipe receives three-edge bearing test.



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News of Engineers

(*Continued from page 23*)

Francis S. Friel, since 1931 president of the Philadelphia firm of Albright & Friel, Inc., has been elected president of the American Institute of Consulting Engineers. Mr. Friel is a former Director of ASCE and a past-president of the Federation of Sewage and Industrial Wastes Associations. ASCE Past-President **Carlton S. Proctor** and **Clinton D. Hanover,** New York consultants, were elected vice-presidents; and **Edward H. Anson,** of New York, and **Harland Bartholomew,** of St. Louis, are members of the Council.

Philip K. Davis has been appointed a vice-president of the Austin Company, engineering and construction firm, with headquarters in Cleveland. Mr. Davis joined the company as a construction superintendent in the Los Angeles district in 1923, and has been at the Cleveland general headquarters since 1953. From 1945 to 1952 he represented the company as project manager for the design of the Atomic Energy Commission's Oak Ridge National Laboratory. **John N. Beckley,** has also been promoted to vice-president and eastern district manager of the company. He will have offices in New York and Roselle, N.J. Mr. Beckley joined Austin's eastern organization as an estimator in 1941 and was appointed acting district manager in 1945.

W. E. Blomgren

Walter E. Blomgren, since 1949 assistant chief engineer of the Bureau of Reclamation at Denver, Colo., retired on January 31 after 42 years of government service. Mr. Blomgren plans to open a consulting office in Denver for irrigation and drainage engineering developments. His career with the government began in 1910 on the Boise Project. After seven years with the Office of Indian Affairs, he returned to the Bureau in 1929 to the chief engineer's office in Denver for work on Hoover Dam. Since then he has served as assistant and regional engineer and assistant chief engineer. In 1954 Mr. Blomgren was chairman of the Executive Committee of ASCE's Irrigation and Drainage Division and has been chairman and vice-president of the United States Committee of the International Commission on Irrigation and Drainage.

Victor Frenkil has been appointed to the Legislative Committee of the Building Congress and Exchange of Baltimore, which surveys all legal matters pertaining to city, state and national construction for the Exchange. **Albert C. Klingenberg** has been appointed to the organization's Committee on Ethics and Practice. Mr. Frenkil is the president of Baltimore Construction Inc., and Mr. Klingenberg is chief of construction for the Baltimore Housing Authority.

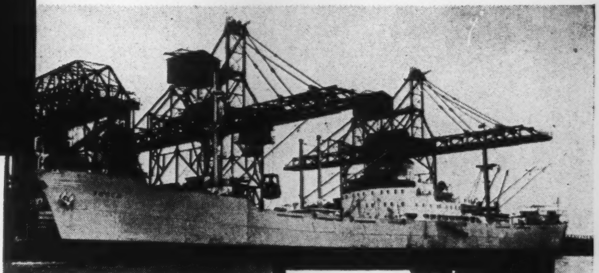
Gerald Charles Ward, Colonel, U. S. Air Force, retired from military service on January 31 to become editor of *Better Roads,* national highway magazine, with offices in Chicago. Colonel Ward recently returned to the United States from France where he was for three years on the staff of Gen. Lauris Norstad. While there he was in charge of the NATO airfield program for the Allied Air Forces of Central Europe. This program will comprise the air defense of the region and will be used by six nations.

John B. Ecker, who has been vice-president and assistant to the president of the Capital Transit Co., Washington, D.C., has been made a director of the firm. Mr. Ecker came to the company in 1929 and has been assistant general manager, general manager, and since 1953, vice-president.

Alfred D. Hutchison, of Greenville, Tex., retired from his position as assistant district engineer of the Texas State highway Department on December 31. Mr. Hutchison was with the Department for 34 years. He is a graduate of Drury College in Springfield, Mo., and the University of Texas.

happy ending of a seven year voyage

First ore from Cerro Bolivar arrives at U.S. Steel's Fairless Works



Unloading the first ore from Cerro Bolivar from the S. S. Tosca at U. S. Steel's Fairless Works, Fairless Hills, Pennsylvania.

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CANO MACAREO
ORINOCO RIVER
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PALUA
PIACOA
LA GRULLA
CIUDAD BOLIVAR
CARONI
EL PAO
MILES
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25
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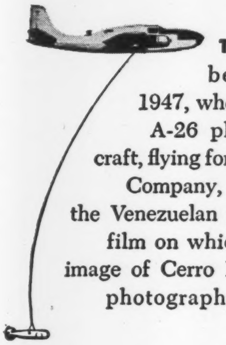
So the vital basic decisions have been proved sound—the long voyage is over, and the first steel has been poured.

When you make the vital decisions which may affect your company's future for generations, let Fairchild provide you with the facts!



THE VOYAGE really began in April, 1947, when one of Fairchild's A-26 photographic aircraft, flying for the Orinoco Mining Company, four miles above the Venezuelan plains, exposed the film on which appeared the image of Cerro Bolivar—truly aerial photography's finest hour.

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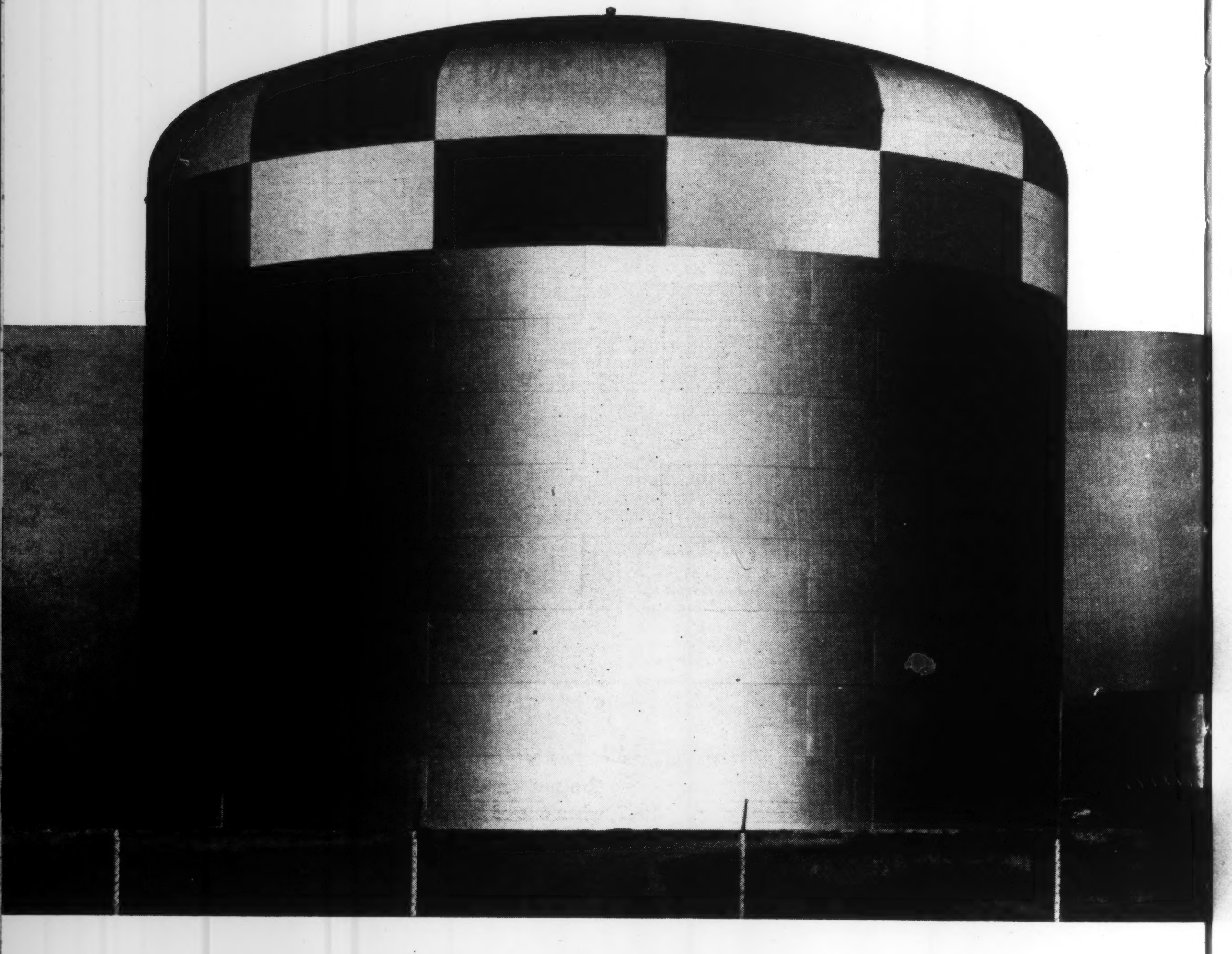

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Gilbert M. Serber was elected president of the American Military Engineers, New York City Post. Mr. Serber is president and managing engineer of the Stock Construction Corporation, New York City, which has handled construction for the New York Port Authority and the New Jersey Turnpike.

Frank Baron will resign his position as director of the Structural Engineering Laboratory at the University of California, June 30. He will continue as professor of civil engineering at the university.

Robert L. McNamee, Samuel D. Porter and **John C. Seeley** announce the reorganization of the firm of Drury, McNamee and Porter, consulting engineers of Ann Arbor, Mich., which will now be known as McNamee, Porter and Seeley, with Mr. McNamee, Mr. Porter and Mr. Seeley continuing as active members, and **William C. Hoad, Ezra C. Shoecraft** and **Walter R. Drury** in an inactive status.

Lynn W. Pine, Colonel, U. S. Army, assumed command of the 311th Engineer Group (now the 24th Engineer Group) at Kaiserslautern, Germany, on December 1. Colonel Pine has been in the army since 1941 and was commissioned in 1946. He then was sent to the Far East Command serving as Assistant Corps Engineer and later as Corps Engineer at Sendai. Later Colonel Pine worked with the U. S. Army's General Staff at Washington, D.C., and most recently has been on a tour of overseas duty.

(*Photo courtesy U.S. Army*)

Colonel Pine

Alan R. Cullimore recently was honored by the Board of Trustees of the Newark, N.J., Schools for Industrial Education on the thirty-fifth anniversary of his becoming head of the Newark Technical School and the Newark College of Engineering. Dr. Cullimore came to Newark from his post at the University of Delaware in 1920. After retiring as director and president of the two schools he continued to serve the college as chairman of the Department of Management and Personnel and now serves as consultant. In 1951 he received the Lamme Medal given by the American Society for Engineering Education "for his achievements as an engineer-citizen."

Roland F. Krebill, who conducts a civil engineering office in Keokuk, Iowa, will work part time as engineer for Lee County, Iowa.

(*Continued on page 28*)

THE SURVEYOR'S NOTEBOOK

Reporting on Unusual Surveying Problems and Their Solutions
Notekeeper: W. & L. E. Gurley, Established 1845

How to Make a Plumb Board for Easier Layouts

"A couple of years ago, windy days, green rodmen and terrain hazards were slowing up construction layout," recalls George Guesmer of Minneapolis. "Reference points were hidden from the transitman by brush, dirt, concrete and construction materials. With the plumb bob swinging in the wind, accurate work became impossible.

"I solved all the problems by making a plumb board. To make one yourself, obtain a builders' three-way plumb and level (used in making an ordinary mason's level) and a piece of plywood ½-inch thick, 48 inches long and the width of the plumb and level (generally three inches). Drill three one-inch holes in the plywood to permit observation of the level bubbles from the rear of the plumb board. Paint the plywood with a couple of coats of flat white.

"After the paint has dried, use black waterproof drawing ink and a ruling pen to draw a line lengthwise down the middle of both sides of the plywood. Graduate the ends of the board in inches—or tenths, if you prefer. The alternating black rectangles make it easy to see the vertical line at a distance. To preserve the inked lines and to keep the board clean, spray the entire board with a clear plastic or brush on a clear spar varnish.

Guesmer plumbing back of obstruction (left); offsetting.

"I found my homemade 48-inch plumb board easy to handle and adequate for most work. It's especially handy for offsetting a reference line or measuring a short distance. I have run many an accurate, trouble-free mile of line using my plumb board, Gurley transits and Gurley levels."

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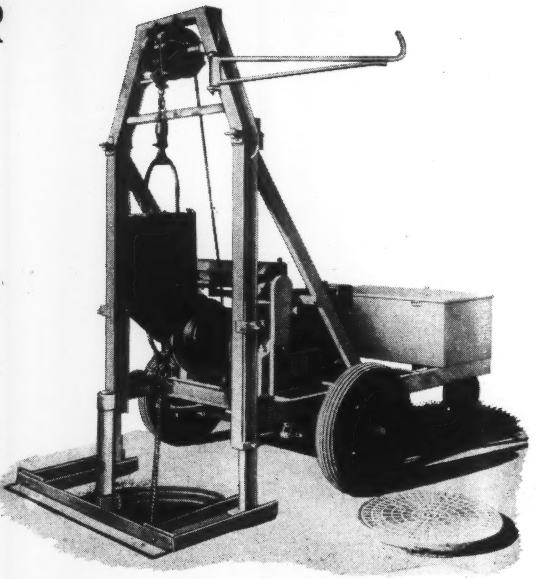

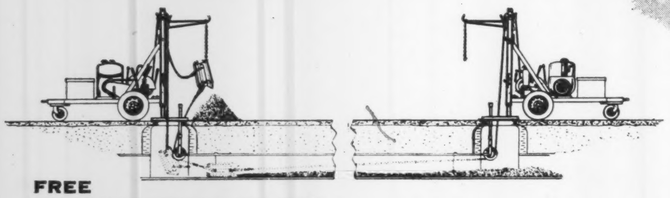

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AMERICA'S LARGEST LINE OF PIPE CLEANING TOOLS AND EQUIPMENT

News of Engineers

(Continued from page 27)

John R. Peet, of Cranford, N.J., has joined the Standard Oil Development Company's staff of the Esso Engineering Division at Linden, N.J. Mr. Peet has been serving in the U. S. Navy, stationed for the past two years in the Philippines.

Carl A. Anderson, district engineer for the San Carlos Irrigation and Drainage District at Coolidge, Ariz., has resigned to engage in consulting work. He was first employed by the District in 1938 and since then has been manager of District affairs. His place as district engineer has been taken by **William S. Gookin,** for a number of years an employee of the Bureau of Reclamation and recently Bureau representative on the Arkansas-White-Red River Basins Inter-Agency Committee.

Guy F. Atkinson, chairman of the board of the Guy F. Atkinson Co., of San Francisco, was honored on his eightieth birthday by 350 celebrants. The testimonial dinner was held in the Sheraton-Palace Hotel on January 15, and a massive portrait of Mr. Atkinson by William Holt was unveiled. In Mr. Atkinson's 64 years in the construction business his company has grown to international importance.

James D. Piper became vice-president of promotion for the Portland Cement Association, with headquarters in Chicago, on February 1. He has been district engineer in charge of activities in Texas, with offices in Austin, since 1949. In his new position he will supervise promotion activities of the Association throughout the country. Mr. Piper joined the Association in 1937 as a structural engineer in its Oklahoma City office and in 1946 was appointed district highway engineer in the Dallas office.

James D. Piper

Wilford D. Hoback, chief engineer of the Oklahoma Turnpike Authority, has been promoted to chief engineer and manager. Mr. Hoback is a resident of Oklahoma City.

Richard W. Cloues announces the opening of an office for the practice of structural engineering at 3991 St. Johns Avenue, Jacksonville 5, Fla. Until recently Mr. Cloues has been chief engineer of the Aetna Steel Co. at Jacksonville.

Richard L. Hearn, of Toronto, since 1947 chief engineer of the Ontario Hydro-Electric Power Commission, has been appointed chairman of the commission. Mr. Hearn, a director of Atomic Energy of Canada, Ltd., has been studying the utilization of power from atomic energy and has taken an active part in treaty negotiations between Canada and the United States for power development of the St. Lawrence River and Niagara Falls. He recently was awarded the Julian C. Smith Medal by the Engineering Institute of Canada for service developing the Province (February issue, page 23) and this month received the Moles award (page 82).

Andrew J. Van Sise, since 1952 in the engineering department of Fayette County, Iowa, has been appointed city engineer of Oelwein, Iowa. He began his new duties on March 1.

John B. Aicher, formerly associated with Heyl, Bond and Miller, Registered Architects, and H. E. Stoudt and Sons, Inc., General Contractors and Engineers, both of Allentown, Pa., has opened an office for the practice of consulting engineering at 25 N. Sixth St., Stroudsburg, Pa. The new organization will be known as John B. Aicher Associates, Consulting Engineers.

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George Hickox has been elected an officer in the Research Branch of the National Association of Land Grant Colleges and is now a member of the division's executive council. Recently Mr. Hickox was appointed director for engineering sciences of the National Science Foundation, Washington, D.C., on leave from the University of Tennessee (November issue, page 23).

E. H. Webster

Edwin H. Webster has been promoted from general manager of the Luria Engineering Company, Bethlehem, Pa., to vice-president in charge of production and purchasing. The company designs and produces standardized steel industrial structures and aircraft hangars. Mr. Webster joined the company in 1948 as a construction superintendent, and was promoted to plant manager in the following year and to general manager in 1950.

Ralph Smillie, of Smillie & Griffin, New York City, and **Charles E. Andrew,** consulting engineer for the Washington Toll Bridge Authority at Tacoma, have been appointed to a board of consulting engineers for the California Toll Bridge Authority on plans for a southern crossing of San Francisco Bay.

James John Rose, government engineer for the past 24 years, has resigned to be area engineer for Knappen-Tippetts-Abbett-McCarthy in Izmir, Turkey. Lately Mr. Rose was chief of the engineering and construction division of the Atomic Energy Commission at Albuquerque and Santa Fe, N. M.

Paul Rogers has announced that the firm, Rogers & Snitoff, Inc., of Chicago, was dissolved as of January 1 and that he will establish a consulting engineering office to be known as Paul Rogers & Associates. The firm will be located at 510 N. Dearborn St., Chicago, Ill., and will specialize in structural design of major structures such as sewage and water treatment plants, bridges, power stations, and multi-story buildings.

Bertram D. Tallamy was recently honored by the University of Buffalo for leadership in the engineering field. He was cited as "director of practically every major project carried on by this state for the last twenty years." Mr. Tallamy is chairman and executive officer of the New York State Thruway Authority and was recently director of the New York State Department of Public Works. Before joining the Department in 1945 he was a member of the Buffalo firm, Fretts, Tallamy and Senior.

TIDE GATES

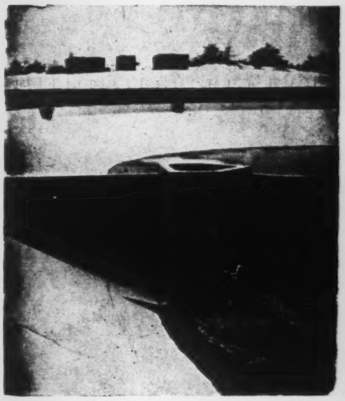

Fig. B-144-A

One of Two 48″ Type M Gates installed in Ft. Stanton Park Reservoir, Washington, D. C., to maintain direction of flow. See Feb. 22, 1954, issue Engineering News Record for story about this project.

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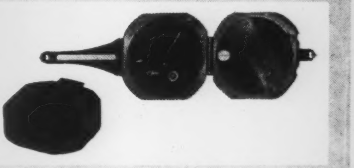

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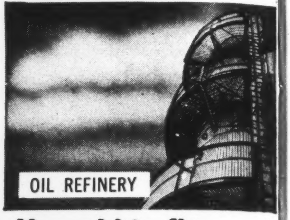
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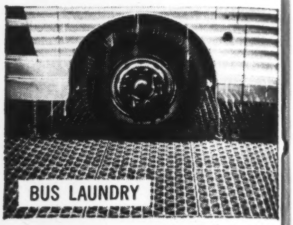
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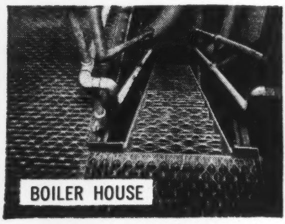
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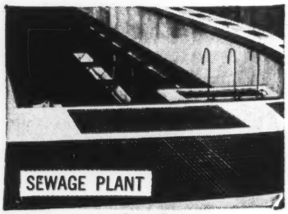
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do you know that

January construction activity was at a peak for the month? The building boom continues to confound the experts, with new construction activity in January (at $2.8 billion) breaking all records for the month. Department of Commerce and Labor analyses lead off "News Briefs."

Accidents don't just happen? So says a sobering research report analyzing all accidents occurring on the Pennsylvania Turnpike in 1952 and 1953. The survey, which is reported on page 84, indicates that 86.5 percent of all accidents were caused by driver error and only 13.5 percent by vehicle failure.

The United States has set a new high in power output? According to data compiled by the Edison Electric Institute, fact-finding organization for the power industry, 10,003,000,000 kwhr were produced in one week in February—the first time we have gone above ten billion. This rate of production gives us 42 percent of the world's power supply and a four-to-one lead over Russia.

You are missing a chance to win a worthwhile Society prize? How many of you remember the Research Program Prize, established by the Board of Direction in 1946 but awarded only once because of lack of takers? The prize, consisting of $100 and a certificate, is described on page 121 of the 1955 Official Register (now in the mails).

Silting will make one out of five of our reservoirs useless in less than fifty years? This is one of many arresting facts about water assembled by the World Health Organization for World Health Day, which is being celebrated April 7 under the theme, "Clean Water Means Better Health."

The President has now made suggestions for financing the proposed $101 billion road program? President Eisenhower's eagerly awaited message to Congress on the financing problem is discussed by the Society's Field Representative in his column on Washington happenings (page 78).

The Board of Direction took action on a number of important matters at its San Diego meeting? These actions are briefed and other Convention news summarized in the "Society News" lead-off.

The first atomic power plant to be built entirely with private funds is in the works? A site along the Hudson near Peekskill, N.Y., has been chosen by the Consolidated Edison Company of New York for the converter-type plant, which will be four years in the building and cost from $30,000,000 to $40,000,000 (page 82).

You can get the proceedings of the recent EJC General Assembly? The proceedings of the January 21 all-day meeting, which produced important information on the manpower shortage, employment conditions and allied subjects, will be available about April 1 at $1 a copy. Your order, with remittance, should be sent to Engineers Joint Council, 29 West 39th Street, New York 18.

Use of tar-rubber paving for military airports in Alaska is planned? Tar rubber will be placed on aprons and sections of runways at the huge U.S. Air Force utility at Galena on the Yukon River as a protection against the corrosive effect of jet fuel on ordinary paving materials. It will be the first such use by the military in Alaska.

Publication of Proceedings papers is being stepped up? With the backlog of technical papers scheduled for Proceedings cleared away, it seems likely that the Society will have facilities for publishing an average of twenty-five papers a month. The present rate of clearance is only about fifteen a month. Present standards will be maintained, of course.

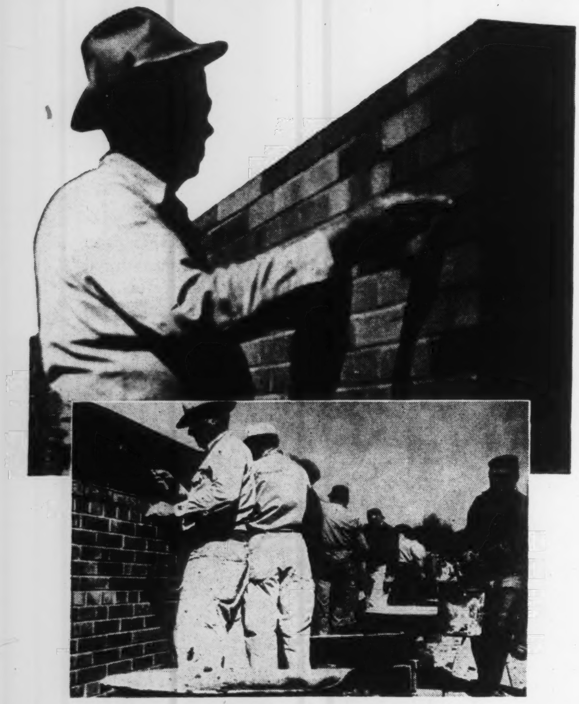
Salt is being used to cope with snow on New York streets this winter? The quickest and least expensive way of attacking snowfalls of less than 5 in. is with common rock salt, says New York City Sanitation Commissioner Andrew W. Mulrain, reporting that the city's recent snowfall, followed by a severe freeze, was cleared up in record time by use of 10,000 tons of rock salt applied by 152 small rotary spreaders.

Packaged aluminum "igloos" are on the market? Designed and fabricated by R. G. Le Tourneau, Inc., the structure provides up to 70,686 sq ft of unobstructed floor area at less than $4 per sq ft. Instead of blocks of snow as structural components, this igloo is made up of fifteen successive rings of sheet aluminum bolted together (March 1954 issue, page 94).

Point to Remember

about Mortar

Why You Get Better Work at Less Cost with Lone Star Masonry Cement



● Good mortar goes hand in hand with good workmanship in good wall performance. Lone Star Masonry Cement assures uniformly highest quality, at lowest cost. Ask the Masons on well-designed Lakeland High School, Cortlandt, N. Y. It adds up this way:

Saves Time at Mixing Box: No lime or portland cement to add, no soaking or slaking. One ready-to-use cementing material means one less variable in proportioning. Rigid control throughout manufacturing means uniform quality from batch to batch.

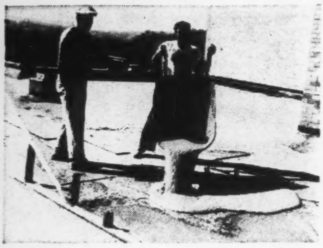
Saves Time on Scaffold: Extra fat mortar spreads easily, doesn't gum up the trowel, easier to tool, makes a neater job, with assurance of strong, permanent bond.

Assures Weather-Resistant Walls: No added waterproofing material needed; inherent water repellency and low absorption protect against weathering action. Chemical soundness safeguards against delayed expansion of joints, saves repointing.

Non-Efflorescent: Lone Star Masonry Cement is practically free from salts; low absorption and high water repellency restrain leaching out of salts in water, sand or brick.

In a word, this is *Lone Star quality,* which means the highest attainable standards. Insist on Lone Star Masonry, the Cement that builds and holds good-will for the Designer and Builder.

For quality and economy, Lakeland High School has a lightweight roof-deck of high insulating value. The deck consists of 1¾ in. precast Porex insulating plank, with ⅜ in. poured-in-place, nailable, 'Incor'-Cement finish. Weight of 2⅛ in. roof deck is 7 lbs. per sq. ft., with insulating value equal to 1¼ in. cork.



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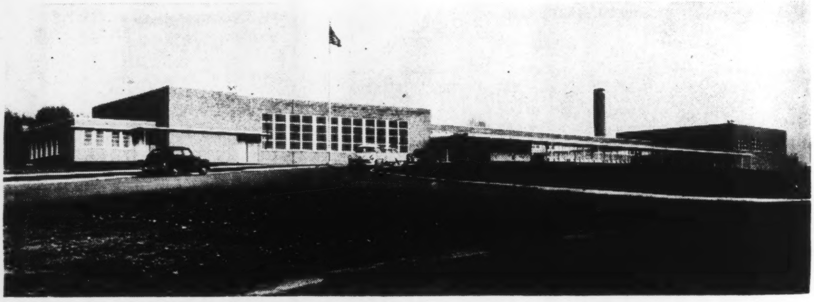
Roofing Contractor:
PORETE MANUFACTURING CO.
North Arlington, N. J.
Lone Star Masonry Cement:
HOME BUILDERS SUPPLY CO., Peekskill, N. Y.



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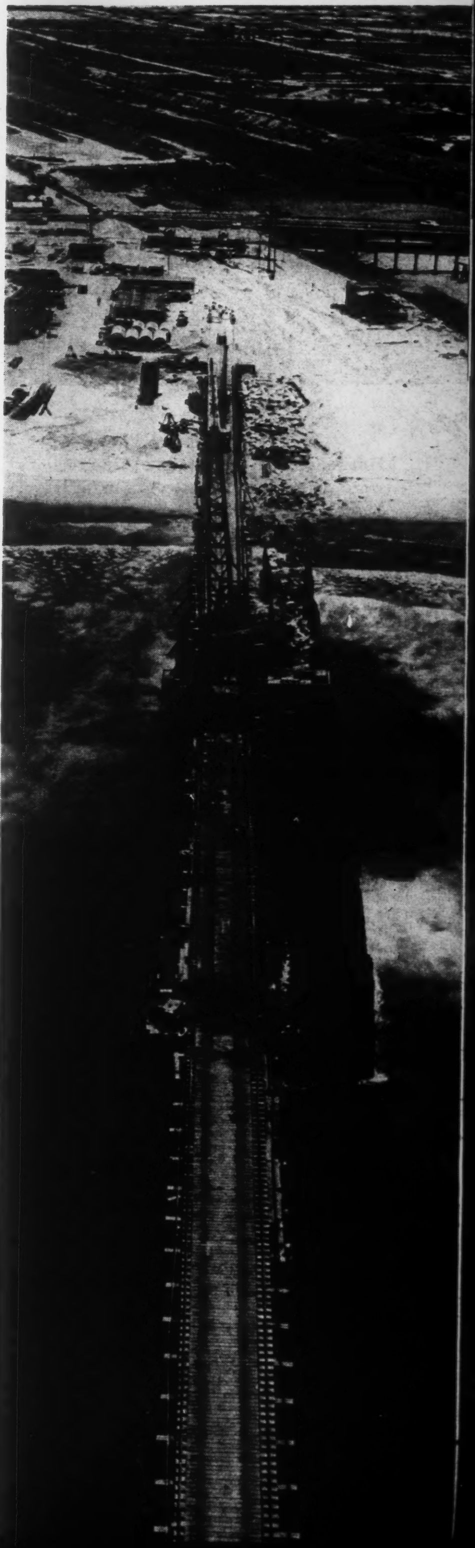
CIVIL ENGINEERING

OUTFALL RUNS 7,000 FT INTO PACIFIC

Inshore section of concrete pipeline placed from temporary trestle, offshore section by whirley on barge in open sea

ROBERT R. HELEN

District Manager, Healy Tibbitts Construction Co., San Francisco, Calif.



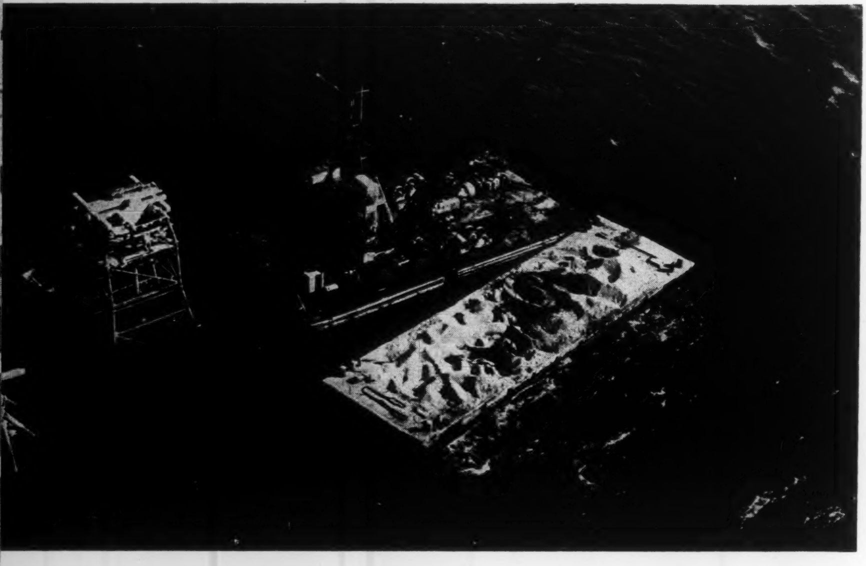
Methods for placing the 7,000-ft-long Orange County Outfall Sewer did not emerge full blown as a completely smooth operation. There were many trials and errors, and it took six weeks of juggling and changes in procedure to organize the routine which finally resulted in a good rate of progress.

This outfall sewer, also called the Santa Ana Outfall, is located at the southern end of Huntington Beach, Calif., just west of the mouth of the Santa Ana River, where the coast line runs approximately east and west and is exposed to weather from the south. Here the beach is wide and sandy, and except for several rock outcrops, the entire ocean bottom for the length of the pipeline is sand with a few traces of fine gravel.

Those who are familiar with offshore operations along the coast of Southern California know that the most ideal working conditions, as far as weather is concerned, are in the fall of the year. Except for an occasional disturbance, the sea is relatively calm, the prevailing westerly winds of summer are over, and there are no tropical storms to cause ground swells. Winter is uncertain. In some years conditions are favorable and in other years very bad. Spring is by far the worst time.

Since the contract provisions for this outfall sewer allowed only one year for construction, it was necessary to disregard seasons and proceed with the work. By the time

Whirley places heavy rock cover on inshore section of Santa Ana Outfall Sewer. Outfall extends 7,000 ft into Pacific Ocean. Outer mile was placed by use of pipe tower and whirley on steel barge.



Final alignment and grade of pipe sections were determined by pipe tower (at left of barge). Clamshell feeds gravel from aggregate barge into hopper on top of tower. Rock cover for pipe was also placed by tower hopper.

the contract was awarded (in September 1952), the pipe manufactured, and miscellaneous details worked out, the fall of 1952 was lost as far as offshore operations were concerned. Construction of the inshore section was started in October 1952 and that of the offshore section in January 1953. The work was completed in January 1954.

In general, the work consisted of furnishing and installing 7,000 ft of reinforced concrete pipe of 78-in. inside diameter. The line runs from high-tide point on the beach, Sta. 0 + 00, seaward to Sta. 70 + 00, where the water depth is 55 ft. The pipe was furnished in 24-ft lengths with a cast-iron bell-and-spigot joint, a rubber gasket making the seal (Fig. 1).

Two distinct types of operation were required: (1) the inshore section from Sta. 0 + 00 to Sta. 17 + 50, placed from a trestle using land equipment; and (2) offshore section beyond Sta. 17 + 50, placed with floating equipment.

Trestle for inshore section

For the inshore part of the job, a temporary trestle 1,750 ft long was constructed, the outer end being in 32 ft of water. The design was conventional, using five-pile bents on 10-ft centers, cutoff at El. + 13.5, 14 × 16-in. caps, 10 × 18-in. stringers under the crane rails, and 8 × 10-in. ties. A roadway for trucks was provided between the crane rails, which were on 14-ft centers. The deck was of 4 × 12's on 4 × 14-in. stringers.

The only unusual feature of the trestle was the omission of conventional X-braces, sash, and longitudinal bracing, purposely omitted to allow free passage of the seas and breakers. In lieu of bracing, a brace pile was driven at every other bent and framed into the cap. The design of the testle was adequate for the 140-ton loading of gantry whirley crane handling a 30-ton section of pipe.

Specifications called for the pipe to be installed between two rows of steel sheet-piling, the piling acting as a cofferdam during construction and thereafter as a permanent protection against scour (Fig. 2). The installation of the steel sheetpiling was the most hazardous phase of the job. As the cofferdam had to be constructed through the breaker line, it was extremely difficult to brace and maintain it during construction, and even more difficult to cut it off at the required elevation.

During the month of August 1953, heavy ground swells from a Mexican tropical disturbance took out 300 ft of cofferdam in a matter of hours. Had the swells hit head on into the cofferdam, it probably would have held, but nothing could withstand the power of the ground swells striking at an oblique angle.

As the cofferdam progressed seaward, the sand was removed from inside it, the bottom course of stone placed and graded, and the pipe and rock backfill placed. The entire job was handled by two whirley cranes operating on the trestle. Yard cranes, carriers, and trucks handled materials to the job site.

A special joint was necessary at Sta. 17 + 00, the junction of the inshore and offshore sections of the work, because of simultaneous pipe-laying operations. On the completion of the inshore part of the job, the trestle was completely removed.

Marine equipment for offshore section

To construct that part of the job from Sta. 17 + 50 to Sta. 70 + 00, an entirely different type of operation was required. Although it would have been possible to construct a trestle for the entire length of the pipeline, the cost would have been far greater than to employ marine equipment, because of the relatively shallow depth of the line as compared with other outfall sewers along the coast.

Mention should be made of the very gradual slope of the bottom from Sta. 17 + 50 to Sta. 70 + 00. In this dis-

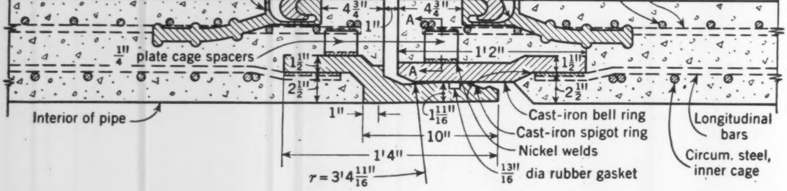
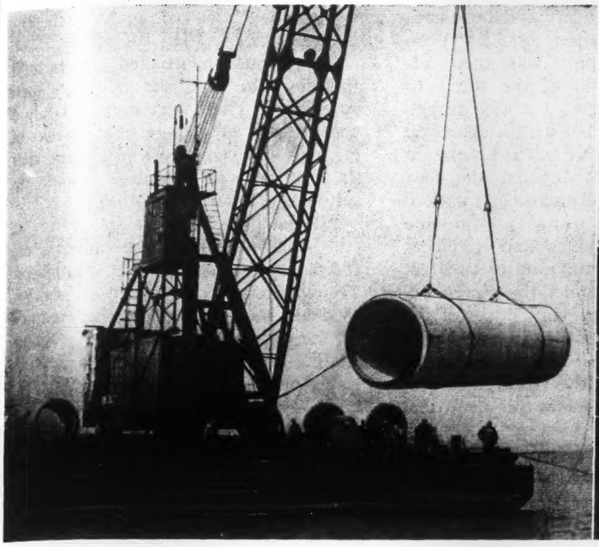
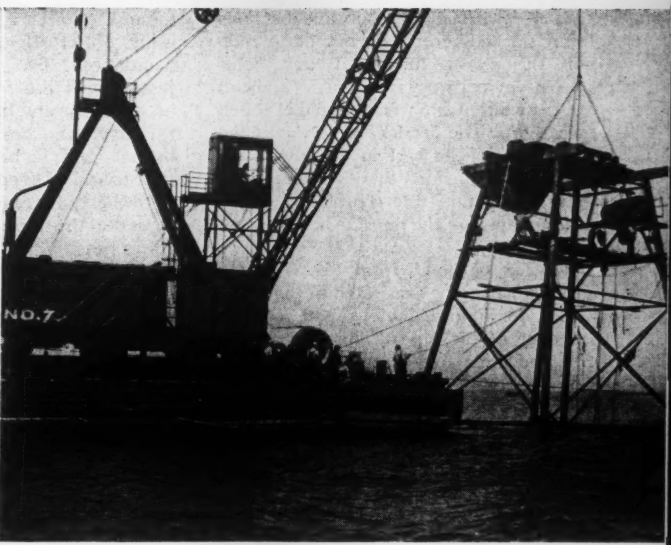


FIG. 1. Positive seal for pipe connection is provided by rubber gasket embedded in spigot. Specifications called for 10-lb hydrostatic test of each connection, with rigid leakage requirements.



Above left:
Barge-mounted whirley hoists 30-ton pipe section for placement in trench previously dredged in ocean floor. Pipe rests on 2-ft layer of gravel placed in bottom of trench. Sections of 6½-ft I. D. concrete pipe are 24 ft long.



Above:
After several lengths of reinforced concrete pipe had been laid out in trench, whirley moved tower over first length for use in precisely positioning it. Water depth at seaward end of outfall was 55 ft.

tance of 5,250 ft, there was a drop of only 25 ft. This condition had an important bearing on the procedure followed for installing the pipeline, requiring precise methods of establishing the grade of each individual pipe length. Ocean outfalls having a considerable downward gradient do not require such precise methods. The use of instruments to control the grade from shore was impractical because of distance, atmospheric conditions, and fog on occasion. Therefore a method was devised of using the water elevation as the control for grade, employing an offshore reference tower.

To install the offshore section of the pipeline, it was decided to construct a movable tower that would rest on the bottom, and to use this tower in conjunction with a whirley-type derrick barge. The tower was constructed of well-braced pipe, in sections so that the height could be extended as the depth of water increased. At the extreme offshore end of the pipeline, in 55 ft of water, the tower was 85 ft high and weighed 30 tons. A two-drum gasoline-powered hoist was mounted on the tower and a 5-ton hand crab was mounted on each leg. On one side there was a gravel hopper, together with chutes and discharge pipes.

After the job was awarded, much consideration was given to the choice of the best type of derrick barge for the work. Many who have had experience in operating derrick barges in the open ocean prefer an A-frame type with a boom and heavy guys that can be well secured for severe weather. As the guy-boom derrick does not have the flexibility needed for the various operations, it was decided to break with precedent and use a whirley type of derrick. In retrospect, it is believed that work was carried on with the whirley in weather in which it would have been imprudent to operate a guy-type derrick barge.

The whirley was mounted on a steel barge and had a lifting capacity of 40 tons. Heavy-duty Skagit hoists made up the anchor engines, and ground tackle consisted of four $3^{1}/_{2}$-ton anchors with two shots of $2^{1}/_{2}$-in. chain on each anchor leading to spring buoys and 2,000 ft of $1^{1}/_{4}$-in. cable on each mooring line. As an additional safety factor, a 5-ton storm anchor with chain and buoy led out astern at all times with a $1^{5}/_{8}$-in. cable to a separate deck winch. During

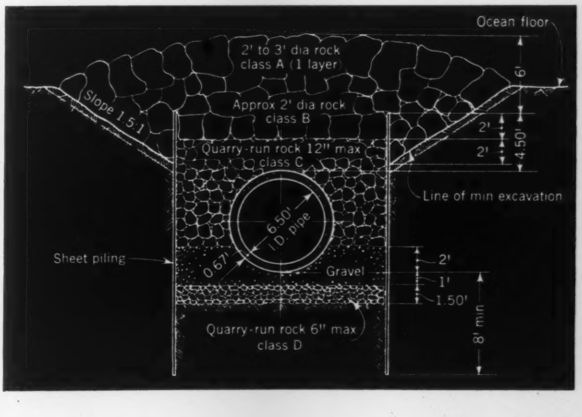

Ocean floor
2' to 3' dia rock class A (1 layer)
6'
Slope 1.5:1
Approx 2' dia rock class B
2'
2'
4.50'
Quarry-run rock 12" max class C
Line of min excavation
6.50' I.D. pipe
0.67'
Sheet piling
Gravel
2'
1'
1.50'
8' min
Quarry-run rock 6" max class D

FIG. 2. Inshore 1,100 ft of pipe was placed between parallel lines of sheetpiling to prevent scour, and embedded in gravel and rock as shown. From Sta. 11 + 00 to Sta. 16 + 25, placement was similar except for omission of layer of 2- to 3-ft Class A rock.

heavy weather all other anchor lines were slacked and the derrick barge rode on the storm anchor. Heavy hold-down devices were installed on the cab of the whirley and were utilized in rough weather. The derrick barge was taken to the site of the work in late January of 1953, and remained there without being brought in until the completion of the offshore part of the pipeline in December 1953.

It can be noted from Fig. 3 that a trench had to be excavated in the ocean floor for approximately half the diameter of the pipe. This was accomplished using an 8-in. sand pump with a pipe suction line and water jet action in lieu of a cutter. This entire unit was mounted on the derrick barge. The cross current was sufficient to permit the material to be discharged over the stern of the derrick without an appreciable quantity returning to the trench. A longer discharge line would have been desirable; however it was impracticable to maintain any type of pontoon discharge line.

All pipe and gravel for the offshore section was loaded on barges in Long Beach harbor and towed to the job site, a distance of 16 miles. Moorings were provided for the barges, and a supply of pipe and gravel was always kept available.

Operations from Sta. 17 + 50 seaward proceeded as follows. Approximately 250 ft of trench was pumped out, using shore ranges for alignment. Pipe sections were then unloaded from the pipe barge and laid out in the trench but not joined together, the distance between each pipe varying with the surging of the derrick barge. Generally the pipe sections were placed from 2 to 4 ft apart. The number of sections laid out at one time varied, depending on the trench available, on weather and other circumstances, but usually five or six pipe sections were strung out.

Positioning the pipe lengths

The pipe tower was then picked up by the derrick barge and placed over the first section of pipe to be entered and joined to that part of the line already completed. Divers rehooked the falls from the tower to slings left on the pipe. Four lead wires from the hand crabs on the four legs of the tower were also attached to the pipe. Next the pipe section was picked up by the hoist on the tower and the divers directed the entering of the pipe. By manipulation of the hand crabs, the pipe was pulled together, aligned, and the joint made.

With the pipe section held in the falls of the tower, in alignment, the next step was to position it to proper grade. By the use of small wires attached to each end of the pipe and drawn tight to the top of the tower, grade was determined, using water elevation as has been mentioned. The pipe was then adjusted with the falls of the tower to proper grade and bedded in with gravel.

Gravel was handled with a clamshell bucket from the barge to the hopper on the tower. Divers directed the flow of the bedding gravel and further packed it under the pipe, using high-pressure water jets. The plans and specifications called for a minimum of two feet of bedding gravel under the pipe. Because of the shifting sand slopes of the trench, it was necessary on many pipe sections to remove sand from beneath the pipe to obtain the required depth. An air siphon was used for this operation.

With the pipe bedded and the slings removed, the next operation was to test the joint to insure its tightness. Specifications called for a 10-lb hydrostatic test of the pipeline with a rigid leakage allowance. Outside of the remote possibility of a cracked pipe, it was recognized that if the rubber gasket was properly seated in each pipe joint the required test could be met. A pipe tester was therefore developed that could be used under water, and each joint was tested before the next joint was hooked up. The tester was modeled after conventional internal joint testers, utilizing two air-inflated gaskets to isolate the joint, the intervening space being subject to either air or hydrostatic pressure to indicate any leaks.

The tester used was fitted out with wheels and a buoyancy chamber, and was left in the pipe. The divers moved it ahead as the pipe laying progressed, and it was finally removed at the end of the pipeline. By this method any crimped or displaced gaskets were immediately detected, and the trouble was corrected before the next section of pipe was placed. On completion of the pipe laying, the final test was made without difficulty. After a joint was tested, the pipe tower was picked up and moved over the next piece of pipe, and the entire process repeated.

As previously mentioned, this method of laying the pipe was not developed overnight. There were many trials and errors and it was only after six weeks of juggling and changes in procedure that the routine was organized which resulted in a smooth operation.

All the pipe between Sta. 17 + 50 and Sta. 70 + 00 was installed before the protective rock blanket was placed. To place the rock, the tower was remodeled. A large hopper was mounted in the center with a telescopic chute leading to a deflecting hopper, which rode the pipeline. By controlling the chute from the tower, a pipe length could be imbedded in rock with each move of the tower. In all, 12,000 tons of rock were placed by this method.

Plans and specifications for the project were prepared by the consulting engineering firm of Harrison & Wooley–Headman, Ferguson & Carollo, of Santa Ana, Calif. The same firm handled the field engineering and represented the Sanitation District. Both the engineering and the contract work for the Orange County Sanitation District was under the direction of Lee Nelson, Chief Engineer and General Manager.

The United Concrete Pipe Corporation of Baldwin Park, Calif., manufactured the concrete pipe for the job.

The $2,050,000 contract for the outfall was awarded to the Healy-Tibbetts Construction Co. in September 1952 and completed in January 1954. For the contractor, Robert R. Helen acted as project manager, with Richard H. Smith, J.M. ASCE, handling the inshore section, and Norman Jennings the offshore section.

(This article was originally presented as a paper by Mr. Helen, at ASCE's San Diego Convention, before the Construction Division session presided over by John P. Hart, a member of the Division's Executive Committee.)

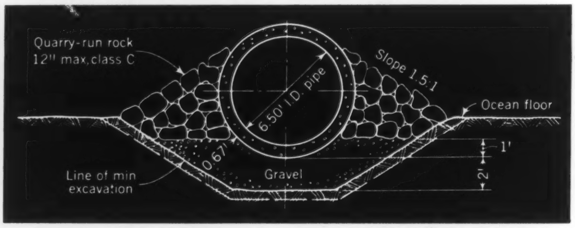


FIG. 3. Seaward end of pipe, in water ranging in depth from 30 to 55 ft, was placed in trench excavated by 8-in. sand pump mounted on derrick barge, and embedded as shown. Rock was not placed until entire length of pipe had been installed.

Maintenance—the Navy's biggest job for civil engineers

JOHN R. PERRY, Rear Admiral, CEC, USN; Chief, Bureau of Yards and Docks, Washington, D.C.

It will probably come as a surprise to many to hear that construction is not the Navy's biggest job for the civil engineer. Maintenance, I believe, is the engineer's most important business in the Navy shore establishment. Maintenance policy is not new in the Navy. It has been said that when a recruit entered the Navy he was instructed to salute everything that moved and to paint everything that didn't. Unfortunately, prior to recent years, the Navy's maintenance policy for the shore establishment was hardly that firm.

In getting to our task in the Navy we were convinced that the money being spent to maintain a shore establishment with an acquisition value in excess of 9 billion dollars could provide more effective maintenance than we were getting. Complicating our problem were the many facilities that were constructed of substitute and inferior materials during World War II and the emergency. Many of these facilities are past their economic life yet must be used until permanent ones can be provided, or until the need for them no longer exists. We had to determine whether we were to maintain our active facilities for an indefinite period, or for a limited period. Inactive facilities had to be protected to a certain degree. Hence, before we could formulate any program of controlled maintenance, we had to establish maintenance standards.

In the past maintenance was accomplished without too much guidance, and its effectiveness depended on the efforts of individuals in the various commands. Naturally we do not intend to discard what has been economically effective, but rather to systematize it and allow its widespread use. Through the establishment of pilot shops we are making great strides in establishing and perfecting procedures. We are holding seminars to sell our program to management, to maintenance supervisors, and to insure uniformity throughout the Navy. We are establishing reporting procedures that will permit us to evaluate our maintenance policy.

Policy, procedures, systems, and controls are of little value without qualified people to implement them at the activity level. We must have an organization of educated, qualified, and conscientious people, including inspectors to carry out a continuous inspection program.

We must further rely on properly staffed planning and estimating groups to translate the deficiencies into work authorizations. They must recognize when to call on engineers for assistance in preparing plans. The work authorization must adequately describe the necessary remedial measures. It must show an estimate of the materials and man-hours by trades necessary to accomplish the work, and must carry a priority reflecting the urgency of the work.

Work authorizations are passed from the planning and estimating group to the shop or work center, where they enter the shop scheduling system. Shop scheduling is most important in that it must consider the available manpower by trade for each job, properly phase the trades in, and establish a starting and completion date reflecting priority. This can be done economically only if the shop has a sufficient backlog of work authorizations.

Up to this point in our controlled maintenance program we have found work that should be done, defined it in terms of labor and material requirements, and performed it on a scheduled basis. Now, what did the job cost? Did it exceed the estimate? If so, why?

Our system to be revealing must permit the separation of cost elements. Fortunately, we live in an age of electric accounting machines and tabulating cards, the use of which makes job cost accounting relatively simple and inexpensive. With a job code system consisting of digits to designate the job, the element contributing to the cost of the job, what generated the work, what work center performed the work, and other desired factors, we are able to prepare reports which management can use as tools in exercising control, both of direct and indirect costs. As the actual is compared with the estimated, and as the delays and other inefficiencies are analyzed, engineered performance standards will develop.

I have dealt with our "controlled maintenance" as generated entirely by the continuous inspection program. Naturally we expect some maintenance work to be generated by breakdowns, trouble calls, and requests. As a general rule breakdowns are costly; however, for any given facility there is probably a ratio of unplanned to planned maintenance work that represents the most economical program. If breakdowns occur too frequently, we must either decrease the interval between inspections or else conduct a more thorough inspection. We should soon be able to establish what percentage of our total maintenance should be on an emergency or breakdown basis.

Obviously there can be two results from such a controlled maintenance program. One will be more and better maintenance for a given amount of money; the other, a given amount of maintenance for less money. Where the level of maintenance has been too low we expect to get the first result; where the level has been satisfactory or too high we expect to get the second result. To date, with this type of program in effect for almost a year, we show an annual saving rate of 8 million dollars with prospects of reaching 11 million.

After all activities are brought to the prescribed standard, we expect to be able to determine the relationship between total station workload and total station maintenance workload in order to hold to our standard throughout any increase or decrease in station activity, at the lowest possible cost.

Other results may prove even more important. Certainly we will be able to apply engineering economics more intelligently in making our comparisons among the different types of structures or facilities. We will be able to discover and eliminate weak spots in existing designs and construction methods. We will be able to do our engineering with a clearer view toward maintenance.

The day of engineering-with-an-eye toward-maintenance is rapidly approaching.

It will affect each of you, although you may be employed strictly in design or construction. The constructor who perfects his techniques to minimize the deteriorating effects of the elements will not go hungry for work. Certainly paths would be beaten to the door of the designer who could come up with a maintenance-free facility.

(This article is an abstract of Admiral Perry's address before the Award Luncheon, at ASCE's San Diego Convention.)

HOTTEST, WETTEST TUNNEL HOLED THROUGH

E. R. CROCKER

Project Manager, Cachuma Project,

Bureau of Reclamation, Goleta, Calif.

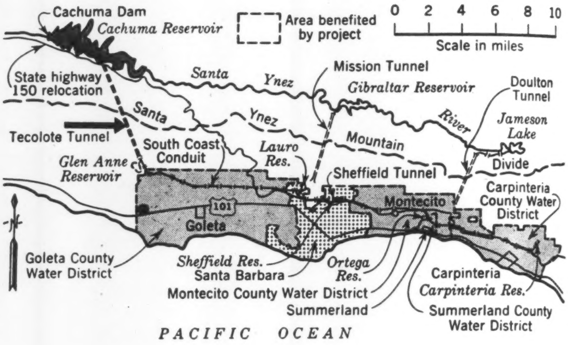

Cachuma Dam
Cachuma Reservoir
Area benefited by project
0 2 4 6 8 10
Scale in miles
State highway 150 relocation
Santa
Ynez
Mission Tunnel
Gibraltar Reservoir
Doulton Tunnel
River
Jameson Lake
Santa
Ynez
Mountain
Tecolote Tunnel
South Coast Conduit
Lauro Res.
Glen Anne Reservoir
Sheffield Tunnel
Divide
Carpinteria County Water District
Montecito
101
Goleta
N
Goleta County Water District
Sheffield Res.
Santa Barbara
Ortega Res.
Montecito County Water District
Summerland
Carpinteria
Carpinteria Res.
Summerland County Water District
PACIFIC OCEAN

FIG. 1. Tecolote Tunnel, 6.4 miles long, carries supplemental water for irrigation and municipal use to coastal strip of California in vicinity of Santa Barbara. Tunnel cuts through rugged Santa Ynez Range to deliver water from Santa Ynez River to narrow coastal plain extending about 15 miles on each side of Santa Barbara.

Tecolote Tunnel was holed through on January 15, 1955, in spite of almost unprecedented difficulties. Although the project is unimpressive in size—7 ft in diameter and 6.4 miles long—site conditions made the work a nightmare. Inflows of water reached 9,200 gpm, and efforts to seal off such flows were hampered by the disintegrated condition of the rock and by heat up to 117 deg F. Dangerous accumulations of methane were encountered, and long stretches of rock swelled and squeezed the H-beam supports into the bore.

This tunnel is the key feature of the Cachuma Project, designed to conserve the erratic flood runoff of the Santa Ynez River and deliver it to the coastal strip adjacent to Santa Barbara, Calif., for irrigation and municipal use.

A brief description of the local geography (Fig. 1) will permit a better visualization of the scope and purpose of the project. Contrary to the popular conception, the coastline of Santa Barbara County, from its boundary with Ventura County to Point Conception, a distance of about 67 miles, extends in almost a true east and west direction. At Point Conception the coastline turns abruptly north and extends generally north about 60 miles to the boundary with San Luis Obispo County. The rugged Santa Ynez mountain range, rising to an elevation of about 3,000 ft, roughly parallels the south coastal line at a distance of from 5 to 8 miles, leaving a strip of flat land and gently sloping foothills from 2 to 5 miles in width for a distance of about 15 miles on each side of the city of Santa Barbara. It is for this coastal strip, including the city of Santa Barbara, that the project will provide a supplemental water supply.

Immediately north of and parallel to the crests of the mountains, which are generally about three miles distant, the Santa Ynez River flows westward to discharge into the Pacific Ocean at Surf, about 20 miles north of Point Conception.

As a feature of the Cachuma Project, Cachuma Dam has been constructed on the Santa Ynez River to intercept and conserve the flood waters of that stream. Indicative of the erratic nature of this flood runoff, the reservoir formed by Cachuma Dam has a capacity of 176,000 acre-ft of divertible water with an estimated annual yield of 33,000 acre-ft. It is the major part of this annual yield that Tecolote Tunnel is designed to divert from the reservoir to the South Coastal Plain.

Tecolote Tunnel pierces the Santa Ynez Range at about El. 650 above sea level and about 2,400 ft below the mountain crest at the point of crossing (Fig. 2). The Santa Ynez Range is composed of rocks of the Miocene, Eocene, and Cretaceous ages, all extensively folded and faulted. One major fault has a stratigraphic displacement of about 12,000 ft. The 6.4-mile tunnel is circular in cross section and has a diameter of 7 ft inside a concrete lining having an average thickness of 8 in. An intake tower is located at the inlet portal in Cachuma Reservoir, at an elevation 90 ft below the water surface elevation at maximum capacity, and is provided with five gates at 19-ft intervals for selective diversion of the reservoir water.

Control gates, access to which is provided through a shaft about 125 ft deep, consist of an emergency 30-in. gate valve followed by a 36-in. tube valve for regulating the amount of water diverted. A 48-in. by 28-in. Venturi meter is provided immediately upstream of the emergency gate. These control works were located 800 ft from the portal in order to keep them downstream of the point where a small drainage channel crosses the tunnel line with a ground surface about 40 ft above the top of the tunnel.

Early tunneling without incident

Bids for construction of the tunnel were opened on December 29, 1949, and a contract was awarded to the low bidder, Carl Halvorson, Inc., of Portland, Ore., and H. Halvorson, Inc., of Spokane Wash., as joint venturers. During the period of advertisement, prior to the bid opening, some prospective bidders expressed concern over the possible water hazard as indicated by other tunnel construction in the Santa Ynez Range, but none apparently visualized the combination of large water inflow and heat that eventually developed.

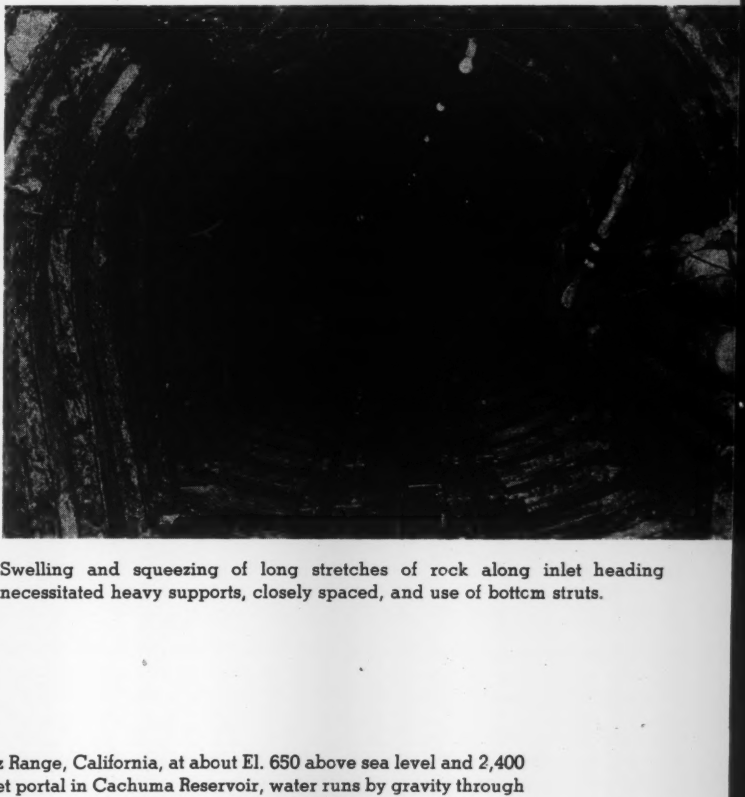
Excavation from the inlet portal began on March 3, 1950. Work on the outlet portal was delayed until May 3, 1950, because of the need of constructing about two miles of access road, much of which was located on rough and precipitous sidehill. For use in excavating the tunnel, the contractor procured conventional equipment modified as required for use in the small bore of the tunnel. At the inlet portal, because of the limited capacity of transmission lines in the vicinity, diesel-powered compressors were used. All other equipment was electrically operated. A blower with a rated capacity of 3,000 cfm was provided, and a steel-pipe ventilating line of 14-in. diameter was installed and extended as the heading advanced. At the outlet portal the installation was similar, except that all equipment was electrically operated.

For the first eleven months, excavation from the inlet portal proceeded without particular incident. The material encountered was a comparatively soft siltstone with occasional small inflows of water. These inflows were at no time sufficient to hamper excavation, but collection at individual locations in pumpable amounts was difficult. Under the combined action of water and traffic, the siltstone in the floor of the tunnel disintegrated into a gooey mass which made track maintenance difficult and foot traffic hazardous.

Loose sand and water encountered

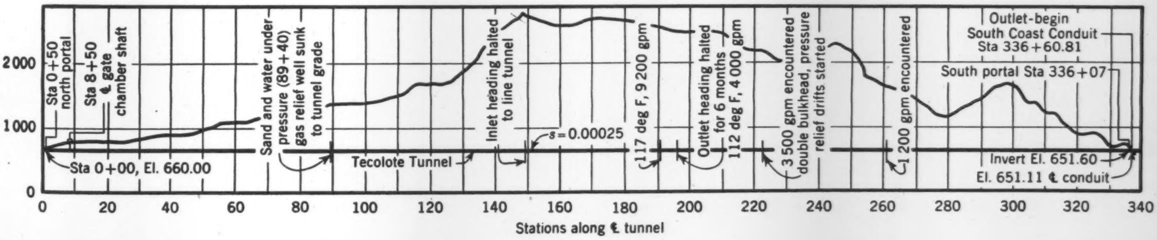
The first untoward incident occurred in January 1951, when the heading had been advanced 8,940 ft from the portal. At this point, while a round was being drilled for shooting, one of the drills suddenly penetrated a pocket or zone of loose sand with water under high pressure. Sand and water spurted from the drill hole in such quantity that before it sealed itself off by clogging, the tunnel

During final phase of excavation, provision was made for handling 10,000 gpm of water through two 12-in. pipes and one 14-in. pipe. Other lines in 7-ft tunnel include two 6-in. compressed-air pipes, one 14-in. ventilation pipe, and smaller pipes and power cables.



Swelling and squeezing of long stretches of rock along inlet heading necessitated heavy supports, closely spaced, and use of bottom struts.

FIG. 2. Tecolote Tunnel pierces Santa Ynez Range, California, at about El. 650 above sea level and 2,400 ft below crest at point of crossing. From inlet portal in Cachuma Reservoir, water runs by gravity through tunnel section of 7-ft diameter to outlet into concrete pipeline leading to Santa Barbara.



Water at 300 psi was encountered during driving of outlet heading. All water-bearing seams were grouted at 2,000-psi grout pressure using two 10 × 3 × 10-in. grout pumps in tandem.

bore at the heading was half full of sand which sloped back to the tunnel invert about 200 ft from the heading.

As soon as the inflow of sand and water ceased, the tunnel crew returned to the vicinity of the heading. As they stood on the accumulated sand, with their heads against the tunnel roof, a sudden explosion burned the faces and heads of eleven men quite severely. However, no permanent injury resulted and all were able to resume work within a week or ten days. Subsequent investigation indicated a rather large inflow of methane gas, and thereafter at this point and at others where regular checking indicated such inflows, provisions were made to keep the atmosphere near the tunnel roof agitated so that explosive mixtures could not develop.

It appeared that, in advancing the heading through the zone of loose sand and water, the sand could be handled if the flow of water could be controlled. However, the rock at the heading proved too weak to hold grout connections under the necessary grouting pressures. The only remedy appeared to be to construct a bulkhead keyed into the surrounding rock through which the grouting could be accomplished. This procedure proved partially successful, and a considerable part of the water was shut off by grouting through on-line and diverging holes extending into the water-bearing zone. This accomplishment was rather remarkable since the grouting of sand is generally considered impracticable. A possible explanation for this success is that the cavern or caverns left in the path of the water when the sand flowed into the tunnel were filled by the grout. The total take of 4,612 sacks of cement would support this conclusion.

At the completion of this grouting effort, the bulkhead was removed and the heading advanced cautiously. Considerable intermittent inflows of sand, water, and gas occurred while advancing the next 200 ft, but the sand and water generally drained out or sealed itself off after running for varying intervals. To reduce the hazard from gas, the contractor drilled a 12-in. well down from the ground surface adjacent to the tunnel line. It extended about 705 ft deep to approximate tunnel grade. This well, located about 9,000 ft from the inlet portal, discharged considerable quantities of gas and was probably effective in reducing the amount entering the tunnel.

After passing through the zone just described, the heading was advanced without particular incident to a point 14,919 ft from the portal, although it was necessary to construct one additional bulkhead through which to perform grouting for the control of water. The above point was reached about the end of March 1951, at which time it became apparent that the closure of the river section of Cachuma Dam would be accomplished before the next flood runoff season, thus making it probable that the inlet portal would be inundated. Therefore it was decided to discontinue advancing the heading so that the excavated part of the tunnel could be lined before flooding occurred.

During the previous year of excavation of the tunnel, it was noted that long reaches of apparently normal rock developed swelling or squeezing characteristics, with the result that many of the steel H-beam supports failed or moved into the bore. During all this time a program of realigning these supports, and of installing additional supports and bottom struts was under way. During excavation, 4-in. H-beams were installed at varying spacing but generally at 5-ft intervals. To maintain the tunnel section, some of these supports had to be replaced with 5-in. and 6-in. H-beams, and intermediate sets had to be installed, practically all with bottom struts. A resurvey of all supports made just before lining was started indicated that lateral pressures were apparently not the same on both sides of the tunnel, and that further realignment of long reaches of displaced supports would be necessary before the lining could be placed.

It appeared that this requirement would delay the lining until the portal area became inundated. By this time, however, the intake tower had been constructed and the tunnel lining placed between the tower and the gate shaft. A review of all factors involved indicated that the date of final completion of the tunnel could be considerably advanced and substantial economy achieved if some means could be devised for lining the inlet leg even though the inlet portal might be inaccessible. Studies made in this connection indicated the practicability of conducting the lining operations through the gate shaft instead of the portal, and it was decided to adopt this procedure.

The one serious difficulty which applies to any lining plan before the holing-through of a tunnel, is to maintain ventilation during the lining operation. In this case the problem was especially difficult because of the small tunnel cross-section. The difficulty was resolved by changing the original horseshoe section to a circular section, deforming the 14-in. fan line to an oval section, and relocating it so it could be embedded in the concrete at one side of the bottom of the section. The section was excavated to approximately vertical sides below mid-height, with provision for later filling it with grout or concrete.

Difficulty with invert cleanup

A serious difficulty encountered early in the lining operations was the bottom cleanup. The gooey mud in the bottom of the tunnel, in combination with the closely placed bottom struts, made this cleanup a most tedious and expensive operation. While the struts generally were located below the minimum concrete line, it was not considered advisable to attempt placement of concrete over this unstable and contaminating material. The problem was largely solved by removing the mud over the struts and as much of that between and around the struts as could be got out conveniently. The remainder was then stabilized and consolidated by displacing it with gravel or incorporating into it as much gravel as it would take. This procedure resulted in a firm, solid foundation for the lining.

In lining the tunnel the entire section, except a segment in the bottom, 4 ft 4 in. wide, for the full distance from a point near the heading to the gate chamber, was placed as the first operation, followed by placement of the bottom segment. Three hundred feet of collapsible steel forms, manufactured by the Noble Company of Los Angeles, were provided for sides and arch, and a traveling jumbo was utilized to move the collapsed forms foward through those still in place as concreting was advanced.

Concrete materials were batched on the surface at the site of the gate shaft, dropped into the tunnel in an elongated batch bucket through a 24-in. ventilating well adjacent to the shaft, and discharged into batch cars in which they were transported to a mixer located at the point of placement. The mixed concrete was discharged from the mixer onto a wet belt which delivered it to a concrete gun. From the gun the concrete was forced through a 6-in. "slick line" to a point above the top center of the forms at the farthest point of placement. Except at the beginning of the placement of a section, the end of the slick line was kept embedded several feet in the placed concrete. Concrete discharged from the gun was allowed to flow on a sloping gradient on each side of the forms and was agitated by internal vibrators manipulated through windows provided in the forms.

Following placement of concrete in the arch and sides of the tunnel, the invert was given a final cleanup and stabilized as previously described. Since the water surface of Cachuma Reservoir had not yet risen high enough to submerge the portal, concrete for the invert lining was mixed outside the tunnel and transported to the point of placement through an access way left in the conduit connecting the intake tower and the inlet portal. The concrete was transported in three agitator cars, each having a capacity of 3 cu yd of concrete. The cars were so arranged that the concrete was progressively discharged from the forward end of each of the two rear cars into the car immediately ahead, and from the lead car onto a belt conveyor, which delivered it to the point of placement. Concrete discharged on the invert was vibrated and brought to grade by a weighted screed traveling on the arc surface of the previously placed concrete on each side of the bottom segment. As the invert lining was placed, holes were cut into the ventilating line buried in the concrete of the side wall, and it was pumped full of concrete.

Excavation from the outlet portal proceeded with no particular incident for the first several months. The rock encountered was uniformly harder and more substantial than in the inlet leg and no squeezing or swelling occurred. Practically no water was encountered until the heading had been advanced about 7,500 ft from the portal. At this point an inflow of about 1,200 gpm occurred.

Workmen were hauled through hottest zone in muck cars filled with "cool" (88-deg) water. Cool water sprays were also provided under which workmen could stand.

Water piped to Santa Barbara

This event coincided with an extreme water shortage in Santa Barbara and the adjacent Montecito District. In Santa Barbara the shortage had been partially overcome by pumping from hurriedly developed wells, but in Montecito very severe rationing regulations were in effect. Arrangements were made to deliver the water accumulated in the tunnel through the just completed South Coast Conduit to the outside limits of Santa Barbara, at which point, by installation of a booster pump, it was introduced into the city's system and, by an existing interconnection, into that of Montecito. This arrangement went far toward relieving the water shortage and permitted lifting of the restrictions on water use. Water encountered in the tunnel has been made available for the use of these communities and the entire project area ever since.

Following this first encounter with a substantial inflow of water, the heading was steadily advanced to a point about 11,400 ft from the portal, although throughout the last few hundred feet water in increasing amounts was met with. At this point, 11,400 ft from the portal, while a round was being drilled, the drills suddenly penetrated a zone of badly crushed shale with water under high pressure, and several hundred yards of this broken shale, about the size of small gravel, flowed or was discharged from the drill holes into the tunnel, together with water totaling about 3,500 gpm.

Small drifts driven

After this inflow was cleaned up, attempts to advance the heading by normal means were unsuccessful. A concrete bulkhead was constructed, through which an attempt was made to inject grout to consolidate the rock and seal off the water, but the grout escaped around the bulkhead through the surrounding fissured rock. A second bulkhead was then constructed about 80 ft downstream, where the rock was stronger. Grouting through this bulkhead appeared to be effective, and about 3,850 sacks of cement were injected. Following completion of this grouting effort, the two bulkheads were removed and another attempt was made to advance the heading. It immediately became evident, however, that while the spaces between the broken shale particles were generally filled with grout, the rock itself was too weak to resist the water pressures. All attempts to advance the heading behind or through breastboards and under heavy timber and railroad rail spiling were unsuccessful as the high-pressure water would wash the broken shale into the tunnel from any point of attack.

After rather lengthy consideration, it was decided to drive small drifts about 20 ft each side of the tunnel line to relieve the water pressure. Rather surprisingly, the rock or shale encountered in these drifts was much less badly shattered than that on the tunnel line. It was found possible, by alternately advancing the drifts and the heading, and thus alternately relieving the water pressure, to progress through this broken shale and water-bearing zone. The total thickness of the zone proved to be about 200 ft.

Since the total amount of water developed in advancing this distance put a severe tax on the available pumping capacity and power supply, it was decided to immediately line this reach of the tunnel with concrete having a minimum thickness of 24 in. This decision made it necessary to enlarge the previously excavated section to provide for the extra concrete thickness and to construct an underdrain to collect and control the water during lining operations. These procedures were successfully accomplished.

The underdrain consisted of an open-joint perforated concrete pipe of 18-in. diameter, laid in a trench excavated below the invert of the tunnel. A steel-pipe extension of this drain was carried through the downstream bulkhead and equipped with a valve. Thereafter, until the capacity of the installed pump discharge pipes was required for additional water met with in advancing the heading, this underdrain was connected to the discharge pipes, and the water confined behind the lining was permitted by its own pressure to force its way out of the tunnel for use in Santa Barbara and Montecito as previously described.

Grout at 2,000 psi

When the lining of this 240-ft section of tunnel was completed, advancement of the heading was resumed. Rock encountered was generally excellent for tunneling, but water in large amounts and under pressure of about 300 psi was encountered. Pilot holes 30 to 35 ft ahead of the heading were continuously maintained, and all significant water-bearing seams were grouted at pressures up to 2,000 psi.

In advancing the next 2,400 ft, 104 grouting setups were made and a total of 18,736 sacks of cement were injected. While this grouting was effective in sealing off large amounts of water, it was not completely successful, and water entering the tunnel averaged about 1 gpm for each foot of advance of the heading. More significant than the water encountered, however, was the gradual increase in its temperature. From about 87 deg F at the point where the lining was placed, the temperature increased to 112 deg F at a point 2,400 ft upstream. This temperature, coupled with about 100-percent humidity, made working conditions almost intolerable. At this point, with 4,716 ft of tunnel remaining to be excavated, the contractor discontinued operations and no further attempt was made to advance the heading for about six months.

During this period, various plans for completing the tunnel were studied. All were concerned with providing a cooler atmosphere in the working area and with handling the existing and probable increase in the amount of inflowing water. At the same time, negotiations were being carried on with the contractor in an effort to arrive at a mutually acceptable basis for resumption of work. These negotiations culminated in an agreement that the high temperature was a condition not contemplated when the contract was executed and that an adjustment in contract prices was therefore in order. At about this time the contractor announced that he proposed to subcontract the completion of the tunnel to the Peter Kiewit Sons' Company and the Coker Construction Company. Under an Order for Changes embodying adjusted prices, these companies, on January 25, 1954, assumed the responsibility for completion of the tunnel as agents of the original contractor.

Rehabilitation of the tunnel, involving reinstallation of unwatering facilities, repair and replacement of the ventilating air duct, and other incidental work, was started while additional equipment and facilities were being secured. A new transformer station at the portal was provided, increasing the available power supply, and a pump and transformer room was excavated in the side of the tunnel about 11,000 ft from the portal and immediately downstream from the short reach of concrete lining previously described. As eventually installed, the equipment included facilities for handling a maximum of 10,000 gpm of water through two 12-in. and one 14-in. discharge pipes.

Ventilating facilities included the originally installed 3,000-cfm positive-displacement fan and four 1,600-cfm compressors, with after coolers and dehumidifiers. These compressors were primarily for the operation of equipment, full advantage being taken of the drop in temperature of the air exhausted from the equipment. In furtherance of this idea, several 6-in. Turbinair AT-25 pumps (furnished by the Joy Manufacturing Company) were installed, the exhaust air being introduced into the main ventilating duct and thus appreciably cooling the air delivered to the heading.

Temperature reaches 117 deg

As soon as sufficient rehabilitation work had been done and the new equipment and facilities installed, advancement of the heading was resumed. Initially working conditions were poor. Although tolerable temperature and humidity were maintained at the heading, temperatures and humidities a short distance back, in the car-passing area and elsewhere, were extremely high. Furthermore, as the heading was advanced, additional quantities of water were developed, and its temperature increased from 112 deg at the point where operations were resumed, to 117 deg at a point only 500 ft further along. The quantity of inflowing water also increased from the initial quantity of 4,000 gpm to a maximum of about 9,200 gpm.

After excavation was resumed, no grouting was attempted. All water encountered was allowed to flow freely into the tunnel. As excavation advanced beyond the point of maximum water inflow, there was a rapid decrease in both the amount and the temperature of the new water developed. The temperature of the water encountered at the heading was about 78 deg F at the time of holing through. With little new water being developed, the total outflow from the tunnel also gradually decreased to about 6,400 gpm.

Advancement of the heading proceeded steadily without particular untoward incident. This progress was only possible through the foresight, initiative, and ingenuity of the contractor. Strategic use of the Turbinair pumps as air-cooling devices, installation of the pump and transformer room near the point of maximum power demand and the maximum water collection area, provisions for hauling workmen through the hottest zone of the tunnel submerged in muck cars filled with cool water, and sprays of cool water under which the workmen could stand at intervals—all made a substantial contribution to efficiency and a high morale.

Now that the tunnel has been holed through—on January 15, 1955—placement of the 18,000 ft of concrete lining, particularly in the hot zone and the area of high water inflow, will further tax the ingenuity of the contractor. Plans for this operation are being developed.

Tecolote Tunnel is being constructed for the Bureau of Reclamation under the general supervision of L.N. McClellan, M. ASCE, Assistant Commissioner and Chief Engineer, as the Contracting Officer. Grant Bloodgood, M. ASCE, Associate Chief Engineer, has been the representative of the Contracting Officer on all general supervision and contract negotiations. E. R. Crocker, Project Manager, has been in direct charge of the work, assisted by R.E. Burnett, A.M. ASCE, Chief of the Construction Division of the Cachuma Project, and Max Hedges, Field Engineer. Carl Halvorson, Inc., and H. Halvorson, Inc., are the contractors for construction of the tunnel. Peter Kiewit Sons' Company and Coker Construction Company have been the subcontractors on the more recent part of the work.

(Mr. Crocker originally presented this article as a paper at ASCE's San Diego Convention, before a session of the Irrigation and Drainage Division presided over by Harry F. Blaney, a member of the Division's Executive Committee.)

Changing engineering education—

Do we understand what has happened?

W. S. EVANS, M. ASCE

Chairman, ASCE Committee on Engineering Education; Professor and Head, Civil Engineering Department, University of Maine, Orono, Me.

The past fifty years have seen many changes in engineering education as in all other lines of endeavor. No matter what business, profession, or game we may be engaged in, it is well to stop periodically, study what has happened in the past, and change our strategy and tactics to suit the period ahead, if need be. It is hoped that some readers of this short discussion will take time to appraise their own educational experience if they are engineers, or to study the engineers in their employ, to see how their formal education could have been improved and to determine what training after graduation would be beneficial.

If the findings of such critical studies are transmitted to the ASCE Committee on Engineering Education, then that committee can do much to point the way toward improvements in education. It is the purpose of this discussion to arouse interest among employers of engineers, and those who work with young graduates, which will lead to thoughtful consideration of educational matters as they affect the profession of civil engineering.

What should the graduate know?

For example, the question has been raised, "What do you think should be the qualifications of an engineering graduate with the B.S. degree?" A well known member of our group recently remarked that he does not need men who know differential equations or advanced theories of vibrations, but men who can set up a transit, do surveying efficiently, and turn out good drawings. Although there is some logic in this man's complaint, he must remember that he is only one of thousands of employers, and any man he might employ might have gone to some other company where advanced theory would be needed. Nevertheless, we must agree that there are reasons, and very good reasons, why our graduates of today cannot go to their first job and make as good an impression with a transit and tape or on a drawing board as could graduates of 30 to 50 years ago.

Another employer of hundreds of engineers told me that the young graduates who come to him cannot make simple decisions, meaning that when they have worked out two or more solutions to a problem, they cannot decide which is the right one. It must be remembered that our graduates have not been trained to make selections. They have been told how to do things and why materials and structures behave as they do, but not how to separate the better from the not so good. That must come with experience.

Needed—an understanding of educational trends

Enough has been said to indicate that there is some dissatisfaction with college graduates who hold the B.S. degree. This is normal, as it is our way of progressing. However, my experience with the Committee on Engineering Education during the past three years has led me to feel that employers of engineers and older men who work with young graduates do not understand the meaning of some of the present-day trends in education. Therefore an attempt will be made to explain some of these trends.

A review of engineering curricula over the past fifty years indicates that the following subjects or fields have been developed almost wholly during that time: (1) reinforced concrete; (2) soil mechanics; (3) moment distribution; (4) highway courses; (5) sanitary engineering; (6) fluid mechanics.

The following courses, although not new, have been added: (1) thermodynamics; (2) electrical circuits, electronics, and electric machinery; (3) technical writing; (4) more humanistic courses; (5) statistics—not too common, but considered highly desirable.

Courses to cover, even inadequately, the subjects listed in the two categories above, require many hours of instruction. Since the hours, days, and weeks are no longer than they used to be, but owing to many causes they are effectively shorter, the time allotted to some fields must be reduced. Some courses that have been eliminated or materially reduced are: (1) graphical statics; (2) practical aspects of foundations; (3) astronomy (for surveying); (4) drawing (time halved); (5) surveying (reduced by about one half); (6) foreign language (also formerly required for admission); (7) thesis; (8) structural detailing.

Why less field work is taught

The past fifty years have seen many changes in the social life on our campuses which also have had a distinct bearing on the attitudes and accomplishments of our graduates, but in the light of the above changes, let us consider the

(*Continued on page 100*)

Use of construction equipment— choice, capacities, economy

WILLIAM B. DICKERSON

District Sales Representative, Euclid Division, General Motors Corp., Cleveland, Ohio

Off-highway rear-dumps have high ratio of net weight to pay load—about 1 : 1. Horsepower and capacity of rear-dumps have been greatly increased in recent years. At top of page, Euclid Model FD, of 15-ton capacity, powered by 190-hp engine, is loaded with iron ore on Mesabi Range. Rear-dump below, of 22-ton capacity, with 300-hp engine, works on turnpike job.

Today's contractor is quite different from the contractor of twenty years ago. Instead of a "hip-pocket" operator, as he was then, he has become an expert in estimating, planning, and operating the larger construction projects. His estimating and cost analyses are highly complex procedures.

Despite larger and more complex projects than ever before, despite higher priced labor and higher operating costs, the price of a yard of dirt or a ton of rock is still the best buy for the American dollar. With huge modern earthmovers, the bid price of moving a yard of earth remains about the same as it was in the thirties. In many cases the price is less. The only answers to this are that the productiveness of equipment has been increased and that job layout and planning have become more thorough.

The present-day contractor has at his disposal many different types of machines. As an example, one contractor on the Ohio Turnpike is moving his yard of earth with a fleet of scrapers, a shovel and rear-dump combination, and a fleet of bottom-dumps loaded by a mobile belt loader. His organization is made up of three different types of equipment on a 10-mile stretch. Actually, he probably could have moved all the earth on this job with a shovel and a fleet of rear-dumps but he selected other types to meet specific hauls and materials.

We will here be concerned only with the "off-the-road" rear-dump, the bottom-dump, and the self-propelled scraper.

Anyone involved in moving a yard of earth is primarily interested in "cost per unit of work." Estimating this cost is no easy task. Many books have been written on cost estimating. Many experienced engineers have dedicated all their time to estimating. Even with years of experience and technical background, many contractors have gone out of business because they made a wrong estimate.

In analyzing an earthmoving job from an equipment viewpoint, one should carefully evaluate the size of the job, the type of material, the weather and time of year, and the time available to complete the project. Other factors in a proper job analysis are grades, haul distances, size of loading units, altitude, size of working area, and state or federal specifications. Typical analysis forms are shown in Figs. 1 and 2.

Factors in equipment choice

In choosing a piece of equipment, important factors are:

1. Accessibility of parts. No piece of construction machinery has ever been built that didn't break down or wear out. "Down time" is costly.

An earthmover should be built with accessible components. The machine with the least amount of "down time" is usually the one that is easiest to work on. Rule number one is, "Choose a machine with accessible parts."

2. Ease of operation. This quality is essentially desirable from the viewpoint of the driver, although the owner is also interested in the ease of operation because it reflects itself in higher production and lower unit cost. The main factors are a comfortable driver's seat, good visibility to the front, sides and rear, and the position and ease of the control. One might say that these characteristics are not related to the type of machine, but rather to the degree of refinement in any machine. However, in many respects ease of operation is actually tied up with the type of machine.

3. Ample horsepower. Three factors control the speed and performance of a loaded earthmover in a hard pull—net engine horsepower, rolling resistance, and gross vehicle weight. We are constantly seeking to improve the utilization of horsepower through better transmissions, torque converters, or couplings.

A useful figure of vehicle performance is the ratio of "bare engine horsepower" to "gross vehicle weight." Rubber-tired hauling units vary from 300 lb per hp to approximately 500 lb per hp. The closer to the 300 lb per hp we can get a machine, the better performance we obtain. Large-diameter, low-pressure tires improve performance by reducing rolling resistance in soft soils.

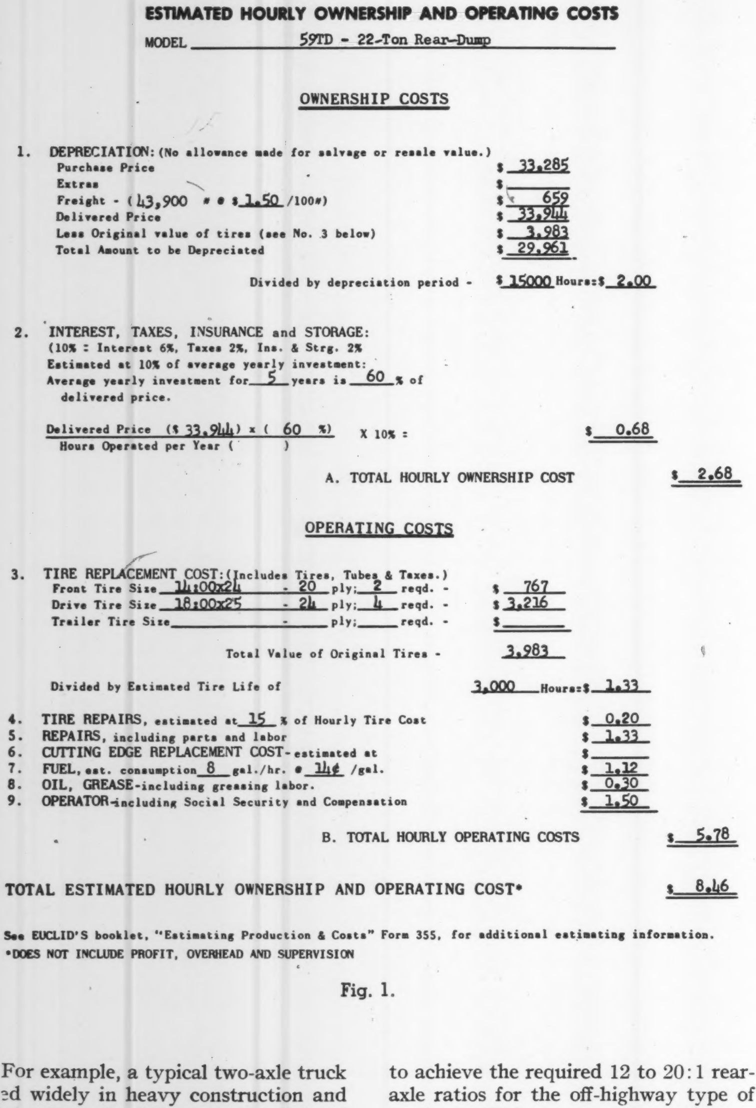
4. Adaptability. No one earthmoving machine is the answer to all types of soil and haul conditions. A buyer must consider future work as well as present work. He not only buys low cost per yard for his present job but also for the lifetime of the equipment. If, however, adaptability is no problem, a specific machine may be selected for only one type of work. After the estimator has determined the job requirements and operating conditions, a tentative selection of the type of equipment can be made. Quite often an estimate is prepared on several sizes of haulers to determine the final relationship of cost per ton or yard hauled. This provides the basis for final selection of equipment.

Off-highway rear-dump

The off-highway rear-dump truck is a piece of construction machinery and not a beefed-up highway-type vehicle. Its construction differs from a highway truck in gearing, weight, speed, and many other features which give it high productive ability, long service life, and minimum maintenance.

Bottom-dump semi-trailers are well adapted to loading in fleets by belt-conveyor loader. They are used primarily to haul free-flowing material over medium to long hauls, where grades are moderate and high flotation is required. Above, Euclid Model FDT tractor, with 15-ton-capacity bottom-dump trailer, is loaded on road-building job. Model below, with 17-cu yd bottom-dump trailer, is busy on New York State Thruway.

Twin-engine scraper (below), with two driving axles, has recently become popular. Front engine drives tractor axle and rear engine drives scraper axle, thus giving greater traction and self-loading in almost all types of soil, without aid of push tractor. This Euclid Model TDT tractor and 18-cu yd twin-powered scraper is seen on road job in Alabama.



ESTIMATED HOURLY OWNERSHIP AND OPERATING COSTS

MODEL 59TD - 22-Ton Rear-Dump

OWNERSHIP COSTS

1. DEPRECIATION: (No allowance made for salvage or resale value.)
Purchase Price $ 33,285
Extras $
Freight - (43,900 # @ $ 1.50 /100#) $ 659
Delivered Price $ 33,944
Less Original value of tires (see No. 3 below) $ 3,983
Total Amount to be Depreciated $ 29,961
Divided by depreciation period - $ 15000 Hours: $ 2.00

2. INTEREST, TAXES, INSURANCE and STORAGE:
(10% : Interest 6%, Taxes 2%, Ins. & Strg. 2%
Estimated at 10% of average yearly investment:
Average yearly investment for 5 years is 60 % of delivered price.
Delivered Price ($ 33,944) x (60 %) / Hours Operated per Year ( ) X 10% = $ 0.68

A. TOTAL HOURLY OWNERSHIP COST $ 2.68

OPERATING COSTS

3. TIRE REPLACEMENT COST: (Includes Tires, Tubes & Taxes.)
Front Tire Size 14:00x24 - 20 ply; 2 reqd. - $ 767
Drive Tire Size 18:00x25 - 24 ply; 4 reqd. - $ 3,216
Trailer Tire Size - ply; reqd. - $
Total Value of Original Tires - 3,983
Divided by Estimated Tire Life of 3,000 Hours: $ 1.33

4. TIRE REPAIRS, estimated at 15 % of Hourly Tire Cost $ 0.20
5. REPAIRS, including parts and labor $ 1.33
6. CUTTING EDGE REPLACEMENT COST - estimated at $
7. FUEL, est. consumption 8 gal./hr. @ 14¢ /gal. $ 1.12
8. OIL, GREASE - including greasing labor. $ 0.30
9. OPERATOR - including Social Security and Compensation $ 1.50

B. TOTAL HOURLY OPERATING COSTS $ 5.78

TOTAL ESTIMATED HOURLY OWNERSHIP AND OPERATING COST* $ 8.46

See EUCLID'S booklet, "Estimating Production & Costs" Form 355, for additional estimating information.
*DOES NOT INCLUDE PROFIT, OVERHEAD AND SUPERVISION

Fig. 1.

For example, a typical two-axle truck used widely in heavy construction and mining has a loaded rear-axle weight of 63,000 lb, which is $3^1/_2$ times the legal highway limit of 18,000 lbs. Not only would it be an overweight on the highway but its width is one-third more than the legal limit.

Off-highway rear-dumps have a high ratio of net weight to pay load. For each ton of pay load, there is a ton of truck, giving a 1:1 ratio as compared with approximately a 0.8:1 on the lighter highway truck. This extra weight is found in the frame, axles, body and hoist; and the power-train components are much heavier than in a highway-type truck.

The rear axles for the rear-dump trucks are of a special design, usually with the final reduction of the planetary type out in the wheel. This planetary type of reduction is used by three leading truck manufacturers in order to achieve the required 12 to 20:1 rear-axle ratios for the off-highway type of service. Highway rear-axle ratios are limited to a maximum of 12:1 because of gear space limitations, price, and speed loss. This planetary final drive reduction reduces the torque loads on preceding power-train components, thus reducing maintenance.

In recent years, the horsepower of off-highway trucks has been greatly increased. Before World War II, the truck most widely used was a 15-ton-capacity truck powered by a 150-hp diesel engine. Today, a truck of the same capacity has 165 to 200 hp. The trend has also been toward larger trucks in the past few years. The torque converter is becoming more in demand, since it eliminates driver error in shifting, reduces shock loads on drive components, and gives higher production on variable grades and haul surfaces.

The capacity of off-highway trucks has broadened in the past few years. Manufacturers now offer trucks of from 10- to 50-ton capacity. Below are listed the size and horsepower range of both single and tandem rear-axle trucks offered today. All have dual tires on the driving axles.

Truck Capacity, tons	Horsepower Range	
	4 × 2 (single)	6 × 4 (tandem)
10	125–150	....
15	165–200	200–275
20	....	200–275
22–25	275–300	....
25	....	200–350
30–34	300–350	300–400
50	....	600
75	....	700

Rear-dumps are used when:

1. The material hauled is large rock, ore, shale, etc., or a combination of free-flowing and bulky material.
2. Maximum grade ability and rapid spotting in a restricted area is required.
3. Maximum flexibility is required for hauling a variety of materials under variable job conditions.
4. Dumping is into restricted hoppers or over edges of a waste bank or fill.
5. The hauling unit is subject to severe loading impact when under a large shovel, dragline, or loading hopper.

Typical job analyzed

Let's take a typical job we might be called on to do. A rock producing company is changing its quarry haul from rail to trucks. They want to know the investment, size of trucks, etc., but the main thing they are interested in is "cost per ton" for hauling. From their information or our observation we find they have an 1,800-ft one-way haul up a 5 percent grade, loaded. The haul road has a 3-percent rolling resistance. They are using a $3^1/_2$-cu yd shovel and the plant requires a production of 340 tons per hour.

In working this problem out, we try several sizes of trucks and find the 22-ton-capacity truck gives the lowest costs because of its size, speeds, etc., and the shovel size. The truck ownership and operating cost is shown in Fig. 1. The hauling estimate is shown in Fig. 2. This cost, however, is the hauling cost only and does not include loading, overhead, or profit.

Bottom-dump uses

The bottom-dump semi-trailer is also a piece of construction equipment and its basic construction is similar to that of a rear-dump. The load is discharged through the bottom of the trailer with the vehicle in motion, and usually falls in a windrow. It is primarily used in hauling free-flowing material, over medium and long hauls, where grades are moderate and where high flotation is required.

The bottom-dump gained its acceptance in the early thirties in flood control and conservation projects along the Mississippi River. Actually, it was one of the first self-propelled, rubber-tired earthmovers made for contractors. The earlier types were gasoline powered of 10-cu yd capacity, and they filled the gap between the slow crawler-tractor hauling a track-type wagon and a highway dump truck.

The early design features are still incorporated in the present-day bottom-dump—large single tires for flotation, short wheelbase for maneuverability, simplicity of design for low maintenance costs, and universal hitch between the tractor and trailer to permit good stability and freedom of trailer movement. The tractor part of the bottom-dump may be a two-wheel overhung-engine type, or a four-wheel type. The four-wheel type is most popular.

The bottom-dump should not be applied to the long, steep grades the rear-dump truck is many times called on to negotiate. There is a weight transfer that takes place on any hauling unit on an adverse grade. In the case of the bottom-dump, the load decreases on the drive wheels and increases on the trailing axle. On the rear-dump, the load decreases on the front or steering axle and increases on the drive axle, thus giving better operation on steep grades with the rear-dump than with the bottom-dump. For this reason, it is generally desirable to limit the operation of the bottom-dump units to a maximum grade of approximately 5 percent.

The bottom-dump can turn in limited areas. For example, the 13-cu yd bottom-dump can turn on a 53-ft diameter, but the 15-ton rear-dump has to have a 65-ft diameter. Listed below are the most widely used bottom-dump sizes along with their tire size and horsepower:

SIZE	TIRE SIZE	HORSEPOWER
13 cu yd	24:00 × 25	190–200
15 cu yd	24:00 × 29	200
17 cu yd	24:00 × 25	275–300
	or 29.5 × 25	275–300
25 cu yd	27:00 × 33	300

The most common application of bottom-dumps occurs when:

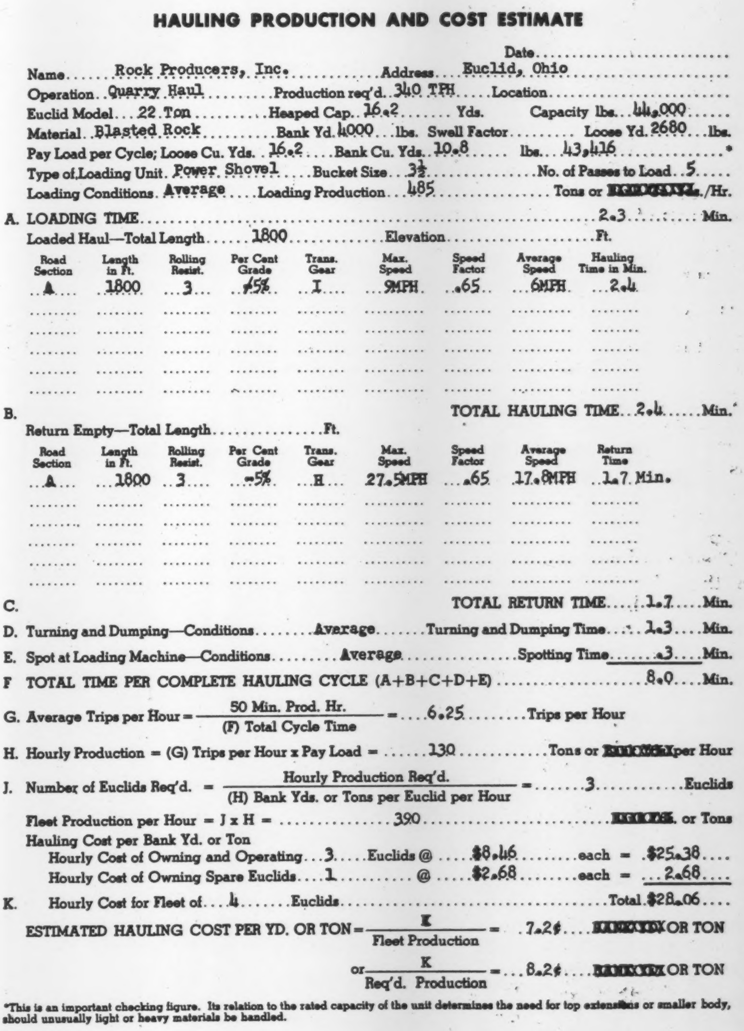
1. The material hauled is free flowing.
2. Maximum flotation of the large single tires is required.
3. The haul is relatively level, allowing high travel speeds.
4. Dumping is unrestricted into a drive-over hopper, or the load is spread in windrows.
5. Long adverse grades do not exceed 3 to 5 percent. (This is recommended as a general rule for optimum performance but is by no means a measure of the actual ability on grades of bottom-dump semi-trailers.)

The belt-conveyor loader has become the most popular way of loading bottom-dumps in recent years. It is possible to obtain higher production with the loader in practically all types of material, from sand to hard clay or shale. The loader and bottom-dump fleets have played the important role on a number of Bureau of Reclamation projects and dams throughout the world where dirtmoving records have been set. The loader is pulled by a crawler in the 125 to 150 draw-bar hp range. An additional tractor is used for pushing where tough material is encountered or increased production is required.

It is important to maintain the proper balance between the number of hauling units and the loader. An unbalanced operation can increase costs as much as 10 to 20 percent. Let's take for example a loader and one tractor along with 9 bottom-dumps having an hourly production of 900 cu yd. The total hourly ownership and operating costs would be approximately $85.12. This would result in a cost of 9.4 cents per cu yd. If only 7 bottom dumps were used, the production would decrease to 700 cu yd an hour and the cost would increase to 9.8 cents per cu yd. Because of the high production of the loader, many contractors have found it wise to keep an extra bottom-dump in the line to insure top production at all times.

Proper loading of either rear-dumps or bottom-dumps is very important.

Fig. 2.



HAULING PRODUCTION AND COST ESTIMATE

Date..........................
Name...... Rock Producers, Inc. .... Address.... Euclid, Ohio
Operation.. Quarry Haul .... Production req'd. 340 TPH .... Location....................
Euclid Model... 22 Ton .... Heaped Cap.. 16.2 ...... Yds. Capacity lbs... 44,000 .....
Material.. Blasted Rock .... Bank Yd. 4000 .. lbs. Swell Factor........ Loose Yd. 2680 .. lbs.
Pay Load per Cycle; Loose Cu. Yds. .16.2 .... Bank Cu. Yds.. 10.8 ..... lbs.... 43,416 ....*
Type of Loading Unit. Power Shovel .... Bucket Size... 3½ .... No. of Passes to Load.. 5 ....
Loading Conditions. Average .... Loading Production... 485 .... Tons or [illegible]/Hr.

A. LOADING TIME.. 2.3 .... Min.

Loaded Haul—Total Length...... 1800 .... Elevation.................... Ft.

Road Section	Length in Ft.	Rolling Resist.	Per Cent Grade	Trans. Gear	Max. Speed	Speed Factor	Average Speed	Hauling Time in Min.
A	1800	3	+5%	I	9MPH	.65	6MPH	2.4

B. TOTAL HAULING TIME.. 2.4 ..... Min.

Return Empty—Total Length.............. Ft.

Road Section	Length in Ft.	Rolling Resist.	Per Cent Grade	Trans. Gear	Max. Speed	Speed Factor	Average Speed	Return Time
A	1800	3	-5%	H	27.5MPH	.65	17.8MPH	1.7 Min.

C. TOTAL RETURN TIME..... 1.7 .... Min.

D. Turning and Dumping—Conditions........ Average ...... Turning and Dumping Time..... 1.3 .... Min.

E. Spot at Loading Machine—Conditions......... Average .... Spotting Time...... .3 ... Min.

F TOTAL TIME PER COMPLETE HAULING CYCLE (A+B+C+D+E)...................... 8.0 ... Min.

G. Average Trips per Hour = $\frac{\text{50 Min. Prod. Hr.}}{\text{(F) Total Cycle Time}}$ = ... 6.25 .... Trips per Hour

H. Hourly Production = (G) Trips per Hour x Pay Load = ... 130 .... Tons or [illegible] per Hour

J. Number of Euclids Req'd. = $\frac{\text{Hourly Production Req'd.}}{\text{(H) Bank Yds. or Tons per Euclid per Hour}}$ = ... 3 .... Euclids

Fleet Production per Hour = J x H = ... 390 .... [illegible] or Tons
Hauling Cost per Bank Yd. or Ton
Hourly Cost of Owning and Operating... 3 .... Euclids @ ..... $8.46 .... each = .$25.38 ....
Hourly Cost of Owning Spare Euclids.... 1 .... @ ..... $2.68 .... each = ... 2.68 ....

K. Hourly Cost for Fleet of... 4 .... Euclids.................................. Total. $28.06 ....

ESTIMATED HAULING COST PER YD. OR TON = $\frac{\text{K}}{\text{Fleet Production}}$ = . 7.2¢ .... [illegible] OR TON

or $\frac{\text{K}}{\text{Req'd. Production}}$ = ... 8.2¢ .... [illegible] OR TON

*This is an important checking figure. Its relation to the rated capacity of the unit determines the need for top extensions or smaller body, should unusually light or heavy materials be handled.

If loading is done by shovel or dragline, the number of loading passes should not be less than three nor more than seven for a good balanced operation. Too many passes of a shovel or dragline increase the loading cycle until it is unprofitable. Too few passes are equally unprofitable since the loading target is small and the operator has to ease his load into the hauling unit. Spillage is a hindrance when the shovel or dragline is too large or the hauling unit too small. The impact or shock of too large a pass increases maintenance, which in turn decreases production.

Self-propelled scraper

The rubber-tired, self-propelled scraper was first introduced in the thirties. Since that time, the dirt-moving picture has changed considerably. The scraper is unique inasmuch as it is able to load, haul, and spread its load in a uniform manner on the fill. The rubber-tired self-propelled scraper extends the working range of a crawler-drawn pull-type scraper to unlimited distances. The self-propelled scraper has also penetrated the bottom-dump market and even the rear-dump market.

The use of self-propelled scrapers has grown in leaps and bounds. Six manufacturers now offer sizes from 5 to 18 cu yd. Below are listed the three general size ranges of self-propelled scrapers:

SIZE	TIRES	HORSEPOWER
5–10 cu yd	18:00 × 25 to 21:00 × 25	125–200
10–14 cu yd	21:00 × 25 to 24:00 × 25	115–280
14 cu yd up	24:00 × 25 to 27:00 × 33	200 up

Design features of the self-propelled scraper have changed more than those of most dirt-moving equipment. This has been due greatly to increased popularity, newer and better engineering features, and high competition among manufacturers.

There are two basic tractor designs on the self-propelled scraper. These are the overhung-engine type and the four-wheel type. The overhung-engine type is most popular in sandy or muddy soil where maneuverability is a problem. The overhung tractor has the ability to twist and turn or more or less snake itself through rough going. The four-wheel type is most popular where roads are rough, hauls are long, and high production is desirable. The four-wheel tractor attains higher travel speeds and gives the operator an easier ride since he is positioned between two axles rather than over one.

There are two basic scraper bowl designs—one the roll-out ejection type and the other the push-out type. The scraper bowl is controlled either by cable or by hydraulic rams.

The twin-engine scraper, having two driving axles, has become popular in the industry over the past several years. In this design, the engine in the front drives the tractor axle and the one in the rear drives the scraper axle, thus giving greater traction and ability to negotiate steep grades. This twin-engine scraper self-loads in 90 percent of soils without the aid of a push tractor.

The twin-engine scraper is used by both large and small contractors. The small operator gets a high-production machine for a small investment as compared with two or three single-engine scrapers. The large operator supplements his fleet with the twin-powered scraper doing odd jobs and performing in areas where traction is a problem. The twin can maneuver in soil conditions where no other scraper can operate.

In comparing one make of equipment with another, too many contractors and engineers find themselves sitting down and looking at competitive specifications, comparing horsepower, size of cable, size of tires, size of steering gear, etc. This is deceptive and only confuses the issue. There is no substitute for actual observation, study, and experience. In choosing one make as compared to another, the user should observe the following general rules:

1. Observe a job similar to the one to be undertaken.
2. Make actual job studies on production, availability, and maneuverability.
3. Discuss your problems with other contractors and get their ideas and experiences.
4. Check on the local distributor, seeing that he offers ample parts and service.
5. Be sure the manufacturer has a good reputation and stands behind his machinery.

Every job is different

We, as a manufacturer, are called on to help in choosing the right type of equipment for quite a few operations. In doing this, we look at each job on an individual basis. Take as an example a yard of good dirt that has to be moved 1,500 ft with very little grade involved. What machine would we recommend and why?

If the contractor is a small operator with limited work, grading industrial sites or small city street work, his job would be analyzed differently from that of a larger operator. Let's assume his required production at 175 to 225 cu yd per hour. His first problem would probably be keeping his investment low and yet having ample production out of a machine that would fit his small yardage. For him, the best machine would probably be two scrapers in the 5- to 10-cu yd class, giving him an investment of approximately $40,000 in the scrapers and $15,000 in a push tractor. The total investment would be around $55,000. Not only does he have a low investment but he has a small machine capable of doing his type of work.

Let's assume the same yard of dirt is to be moved the same distance by a little larger contractor doing subcontract overburden stripping, or maybe a small state highway road job. Let's put his required production at 300 to 500 cu yd an hour. He would also like a small investment but production requirements would be a little higher. This would be a good job for two twin-powered scrapers. Here he would have an investment of approximately $100,000 and yet could maintain the required production.

Taking the same yard of dirt and moving it on a larger scale, such as an air-base project, requires another approach. Let's assume on this particular job that the required production is 400 to 600 cu yd per hour. Here is where five single-engine scrapers and two push tractors would fit. This fleet would meet the required production and call for an investment of approximately $225,000.

On the other hand, let's have a required production of 1,100 cu yd an hour on a turnpike project. The best adapted fleet could very well consist of seven bottom-dumps and a loader. The bottom-dumps, loader, and two tractors would result in an inventory of approximately $300,000.

In these examples we have seen the same yard of dirt moved by contractors of four different sizes with four different types of equipment. The amazing thing is that the cost per yard would not vary too much in any of these operations. Yet a misapplication of small scrapers in the 5- to 10-cu yd class to a huge earth-fill dam, or an attempt to use a loader and a bottom-dump fleet in small scattered borrow pits would mean rising costs, greater overhead, job delays, and generally a less than satisfactory result.

The modern successful contractor carefully analyzes his own operations and the nature of the work to be done. He carefully reviews all makes and types of equipment to get the lowest possible costs over the *lifetime* of the equipment, and over a wide range of operating conditions. Such contractors will help this country and other countries to fulfill demands in the greatest era of road-building the world has ever seen.

(This article was originally presented by Mr. Dickerson at the ASCE Annual Convention in New York, before the Construction Division Session presided over by Warren N. Riker and Walter L. Couse, Members ASCE.)

Completed in 1953, modern diversion dam on a mountain stream diverts water through 9,250-ft Kohrang Tunnel to headwaters of Zaindeh River for use in irrigating 25,000 acres of new land near Isfahan (No. 1 in Fig. 1 and Table I).

Iran develops its rivers

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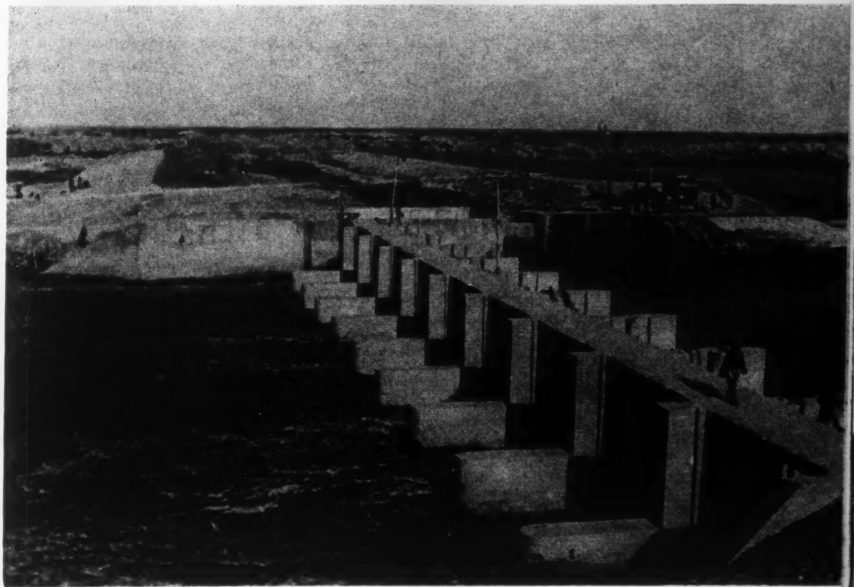
Modern dams replace ancient structures and activate new projects, mainly for irrigation, but also for power and flood control

With the solution of its oil problem, Iran will give first priority to the building of dams for irrigation and power. In the program to develop the country, two economic surveys and reports on the resources of Iran have been made since World War II. The Independent Irrigation Corporation of Iran, a government agency known as the Irrigation Department, has the responsibility of river developments. The Iranians have formed a Planning Organization to implement the program, with financing from oil revenues.

Of Iran's 20,000,000 people, 75 percent live on the land and are dependent on agriculture for their livelihood. Most of the country consists of high moun-



Typical river diversion structure is Miyan-Kangy Dam which feeds canal on far bank. Gates were installed in August 1954 in this unit of Sistan Project, on Hirmand River in eastern Iran (No. 2 in Fig. 1 and Table I).

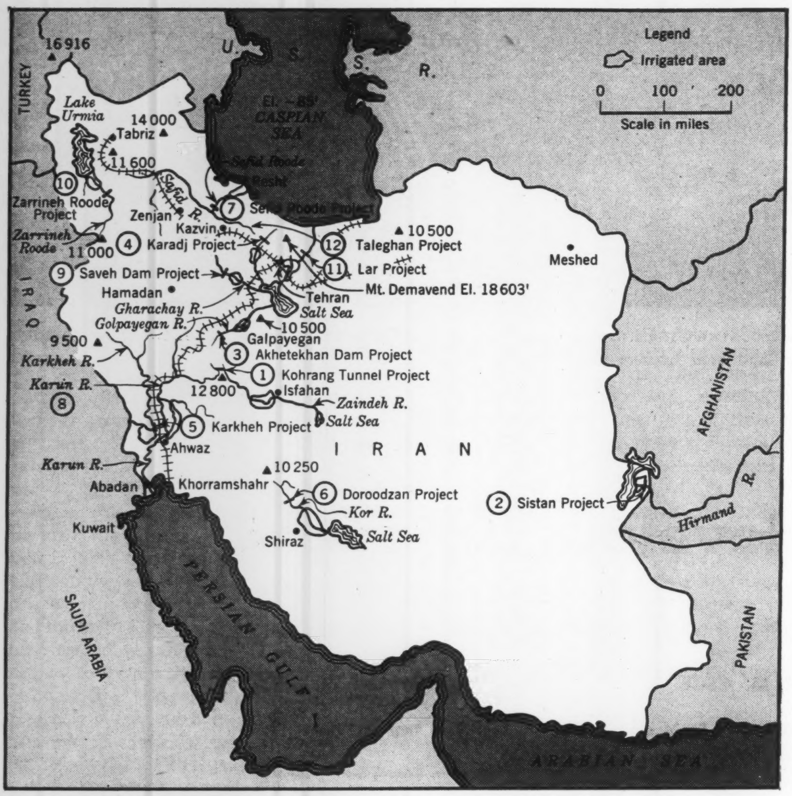

Legend
Irrigated area
0
100
200
Scale in miles
TURKEY
16916
U.
S.
S.
R.
Lake Urmia
14 000
Tabriz
11 600
El. −85'
CASPIAN SEA
Sefid Roode
Resht
10
Zarrineh Roode Project
Zarrineh Roode
11 000
Zenjan
Safid R.
Kazvin
7 Sefid Roode Project
4 Karadj Project
12 Taleghan Project
10 500
11 Lar Project
Meshed
9 Saveh Dam Project
Hamadan
Tehran
Mt. Demavend El. 18603'
IRAQ
Gharachay R.
Salt Sea
Golpayegan R.
10 500
Galpayegan
9500
3 Akhetekhan Dam Project
Karkheh R.
1 Kohrang Tunnel Project
Karun R.
12 800
Isfahan
8
Zaindeh R.
Salt Sea
5 Karkheh Project
Ahwaz
I R A N
AFGHANISTAN
Karun R.
10 250
Abadan
Khorramshahr
6 Doroodzan Project
Kor R.
2 Sistan Project
Hirmand R.
Kuwait
Shiraz
Salt Sea
SAUDI ARABIA
PERSIAN GULF
PAKISTAN
ARABIAN SEA

FIG. 1. Twelve projects included in Iranian Government's current development program are spotted on map of Iran and numbered in conformity with Table I, which gives additional data.

TABLE I. Status of river development projects in Iran

	Project	River	Status	Storage, acre-ft	Irrigated Area, acres	Power, 1000 kw
1.	Kohrang Tunnel . . .	Karun to Zaindeh	1953*	Diversion	25,000	0
2.	Sistan	Hirmand	1954*	Diversion	112,000	0
3.	Akhetekhan	Golpayegan	1955†	22,600	12,500	0
4.	Karadj	Karadj	1958†	390,000	25,000	33–93
5.	Karkheh	Karkheh	1954*	Diversion	200,000	0
6.	Doroodzan	Kor	Plans complete	650,000	80,000	6
7.	Sefid Roode	Sefid	Preliminary	1,500,000	150,000	10–20
8.	Karun	Karun	Preliminary	. . . . .	. . . . .	. .
9.	Saveh	Gharachay	Preliminary	81,000	. . . . .	1.6–2.4
10.	Zarrineh Roode . . .	Zarrineh	Preliminary	. . . . .	. . . . .	. .
11.	Lar	Lar	Preliminary	. . . . .	. . . . .	144
12.	Taleghan	Taleghan	Preliminary	. . . . .	. . . . .	. .

* Completed.

† Under construction, scheduled completion date.

tains and plateaus, and the rainfall is usually insufficient for normal crops.

Ancient works still remain

Irrigation has been practiced for centuries. In southern Iran, on the Karun River, near project No. 5 in Fig. 1, the remains of extensive irrigation canals built over 2,000 years ago can still be seen. Many canals are still fed from small diversion dams of brush. On the Kor River near Shiraz, there are several masonry dams which have been in use for over 500 years. At Saveh, near the city of Qum, on the Gharachay River, a masonry dam 60 ft high, built some thousand years ago, is still standing—near project No. 5 in Fig. 1. This ancient rubble dam failed as a result of piping under the foundation. Another ancient method of obtaining water for both irrigation and domestic use is still employed. By this method a relatively high-level source of ground water is tapped near the mountains and conveyed through tunnels which are brought to the surface at lower elevations. (See CIVIL ENGINEERING, February 1933, p. 69.) These tunnels, called ghanats, are dug by hand from vertical shafts sunk about every 150 ft. The flow is by gravity, and lacking effective regulation, is wastefully used.

In recent years, several hundred wells have been drilled, some diesel-engine operated, some motor driven with electric power supplied from diesel-electric generating stations. In southwestern Iran, 150 electric well pumps irrigate groves of dates and citrus trees.

New projects studied

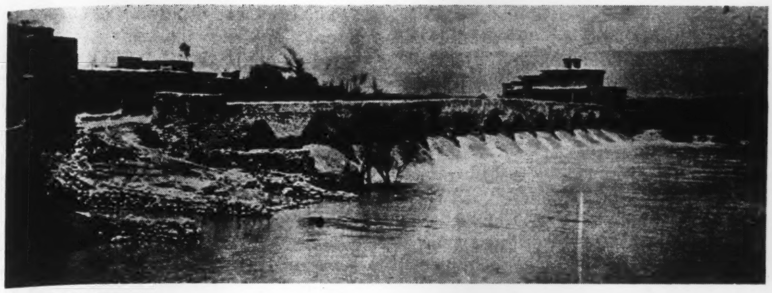
Over the past six years the Irrigation Department has implemented studies of river projects. Three projects have been completed; two others are in various stages of construction; and several others are under engineering study. These projects are shown in Fig. 1 and numbered as in Table I, where additional information on them is given. More detailed descriptions follow.

Consulting engineers have been employed by the Irrigation Department to bring these studies to a conclusion and to prepare detailed plans. The firms employed for this work have been of French, German, English, United States, and Iranian origin.

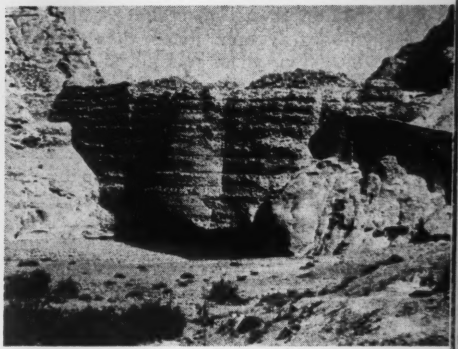
Many river gaging and weather stations have been established to supply hydrological data; reservoirs and areas to be irrigated have been surveyed; and teams of UN-trained Iranian agricultural engineers are classifying agricultural areas.

Projects completed and under construction

1. Kohrang Tunnel. Completed in 1953, the Kohrang Tunnel diverts water from the upper reaches of the Karun River, which discharges into the Persian Gulf, to the watershed of the Zaindeh River and augments the irrigation supply in its valley near Isfahan, a city of 200,000 population. The Zaindeh River discharges into a salt lake with no outlet. Many years ago one of the kings of Persia started excavating a canal through the mountains, but because of the heavy rock excavation abandoned the scheme. The present tunnel is a 10-ft 8-in. horseshoe, lined with concrete or masonry, and is 9,250 ft long. The diversion dam across the Karun River is of rubble masonry 33 ft high. The water flows through



Still in operation although built over 500 years ago, Band Amir diversion dam is on Kor River near Shiraz (near project No. 6 in Fig. 1).



Ancient rubble dam at Saveh failed as result of piping under foundation. This 60-ft-high structure, built a thousand years ago, is to be replaced by modern rock-fill dam (No. 9 in Fig. 1 and Table I).

the tunnel by gravity, and the maximum discharge is 1,050 cfs. As a further development of this project, storage reservoirs are planned on the Zaindeh River. At the present stage of the project, the diverted water can be used to irrigate 25,000 acres of new land in the fertile area near Isfahan and to supplement the irrigation of additional land.

2. Sistan Project. Miyan-Kangy and Zehak Dams are concrete diversion structures on the Hirmand River for diverting water to the Sistan Plain in eastern Iran. Each dam has nine gates 13 ft 9 in. × 19 ft, and diverts 880 cfs, which will irrigate a total area of 112,000 acres. The dams were completed in 1953, and the gates were installed in August 1954.

3. Akhetekhan Dam. This rock-fill structure, 171 ft high, was completed in the fall of 1954. The outlet structures are scheduled for completion in the spring of 1955. It creates a storage reservoir on the Golpayegan River, 130 miles southwest of Tehran. The town of Golpayegan, 15 miles below the dam, is in an agricultural area supporting about 80,000 inhabitants. The area is dependent for its water on the Golpayegan River, which discharges into an inland salt sea. Since there is no rainfall from April to early October, no crops can be raised without irrigation. Above the dam site, there are 425 sq miles of drainage area, including the snow-capped Bakhtiari Mountains which rise 6,000 ft above sea level. The March floods will be stored in the reservoir and released during the growing season.

A section through the rock-fill dam is shown in Fig. 2. The foundation, like the surrounding hills, consists of a metamorphic phyllitic schist rock, suitable for any type of dam. Concrete is relatively expensive in this area because of the high cost of cement and transportation difficulties. Aggregates would have to be transported long distances.

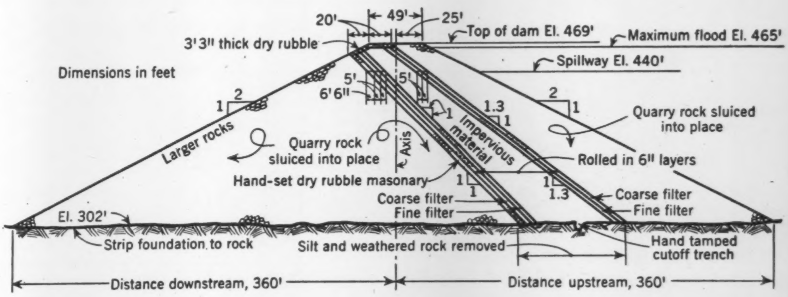
A saddle in the hillside on the right abutment afforded a spillway site. The material from the spillway was used in the rock fill. Material for the fine filter was gathered from the river bed, and the gravel filters were graded from the rock excavation. An impervious section of clay and silt was taken from borrow pits in the area immediately above the dam.

During construction the river was diverted through a concrete-lined tunnel of horseshoe shape and 16.4-ft diameter, in the left abutment. The tunnel is 980 ft long, and the water was diverted by an earth-fill cofferdam across the river channel. The tunnel will also serve as an outlet for the discharge of irrigation water through a 36-in. pipeline constructed in it.

The contract for the Akhetekhan Dam was awarded to an Iranian contractor. After many delays and indecisions, the contractor purchased two diesel-operated power shovels of 2- and $1^1/_2$-cu yd capacity, six Euclid dump trucks, a caterpillar D19 with bulldozer, and sheepsfoot rollers. Most of the rock for the dam came from the spillway cut. To supply the rock for the upstream section, however, a quarry was opened on the left abutment. Construction work was partly shut down during the winter months because of the severe weather and the difficulties of transportation over the 21-mile access road.

Sheepsfoot rolls impervious core, placed against dry rubble of rock-fill Akhetekhan Dam (No. 3 in Fig. 1 and Table I).

FIG. 2. Akhetekhan Dam, 171 ft high, is of rock fill with impervious section. See No. 3 on map, Fig. 1, and in Table I.



20'
49'
25'
3'3" thick dry rubble
Top of dam El. 469'
Maximum flood El. 465'
Spillway El. 440'
Dimensions in feet
5'
6'6"
5'
2
1
1
1.3
1
2
1
Larger rocks
Quarry rock sluiced into place
Axis
Impervious material
Quarry rock sluiced into place
Rolled in 6" layers
Hand-set dry rubble masonary
1
1
1
1.3
Coarse filter
Fine filter
Coarse filter
Fine filter
El. 302'
Strip foundation to rock
Silt and weathered rock removed
Hand tamped cutoff trench
Distance downstream, 360'
Distance upstream, 360'

The spillway cut required 650,000 cu yd of excavation. In the dam there are 750,000 cu yd of rock fill and 172,000 cu yd of earth and filter materials. When full, the reservoir will store 22,600 acre-ft.

4. Karadj Dam. In December 1953, the contract for construction of the multipurpose Karadj Dam was awarded to Morrison-Knudsen International. This is the most ambitious project yet undertaken by the Iranian Government. The dam is on the Karadj River about 40 miles northwest of Tehran. It will provide domestic and industrial water for Tehran, electric power for the area, irrigation water for 25,000 acres, and flood control for the valley below the town of Karadj. The area that will benefit from the project, including Tehran, has a population of 1,400,000.

Rock at the dam site, located in a gorge of the Karadj River, is diorite, an intrusion in the surrounding limestones. The river rises in the Elbroz Mountains and falls rapidly about 13 ft per thousand through the gorge to the plains below the town of Karadj. Precipitation in the mountains is in the form of snow, which regulates the river flow during the summer months. According to a study based on eight years of gaging records, the total average annual flow is 535 cfs.

For the dam, a variable-center concrete arch 610 ft high was chosen. The upstream face is vertical up to El. 279 ft above the foundations; above this elevation the circular curve has a radius of 820 ft (Fig. 3). The radius of the axis of the dam is 656 ft. Provision has been made for an earthquake shock having an acceleration of 0.12 *g* for a period of one second. The top width of the dam is 20 ft.

Construction of the diversion tunnel is completed. This concrete-lined tunnel has a circular cross section of 18-ft diameter and a total length of 1,360 ft. Rock-fill cofferdams are to be built at each end of the foundation area to divert the water through the tunnel and keep the working area dry.

Two spillways have been provided—one to handle normal flows up to 14,200 cfs and the other to handle the additional flow above this up to a total of 28,400 cfs. The spillway for normal flows consists of an intake structure and a concrete-lined tunnel located on the right abutment a short distance upstream from the crest of the dam. This spillway has an overflow section, one radial gate, and a tunnel of 18-ft diameter. It will discharge downstream from the dam and power plant near the outlet of the present diversion tunnel. The tunnel is designed to flow about 0.8 full under maximum discharge.

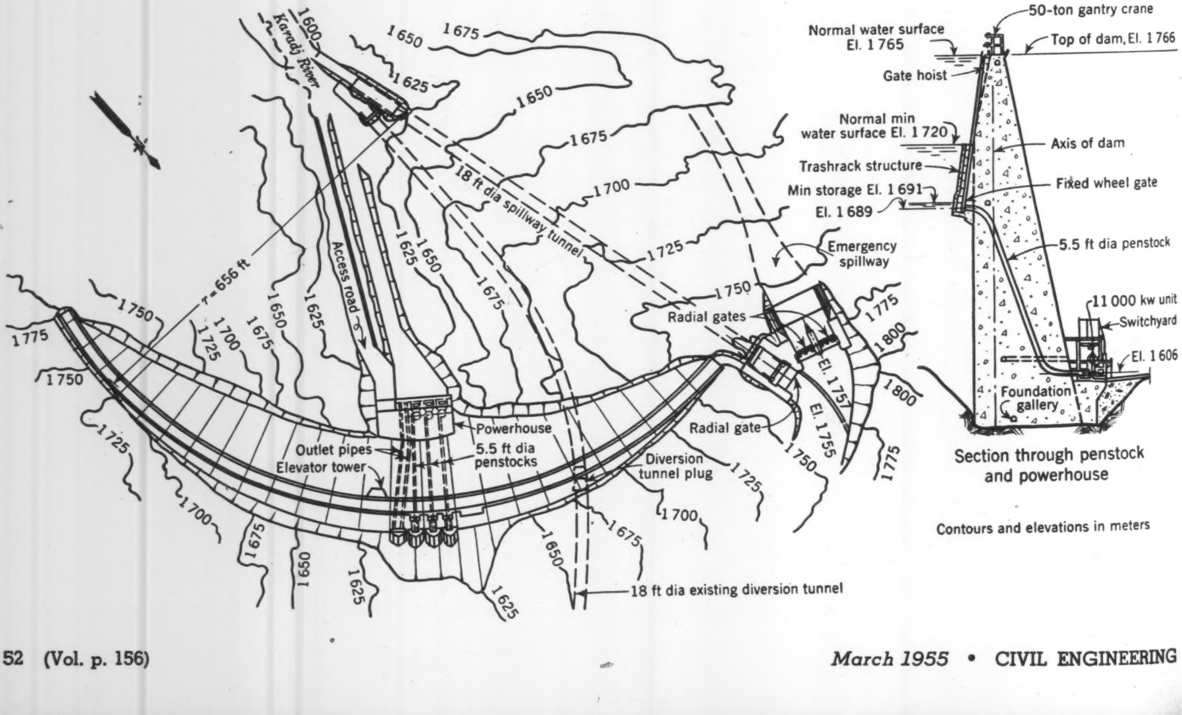
The emergency spillway, to pass additional flows of 14,200 cfs, is also located in the right abutment, just upstream from the tunnel spillway. It consists of a gated concrete-crest structure which discharges into a concrete-lined channel leading to a location a short distance downstream from the right abutment of the dam. The spillway crest is controlled by two radial gates which will be operated only when flows exceed the capacity of the tunnel spillway.

Outlets through the dam are of sufficient capacity to supply the needs for irrigation and domestic water when the power plant is not operating. Outlet pipes with intake elevations 164 ft above the stream bed and regulating valves are designed to discharge 880 cfs. These outlets will also be used to handle the river discharge during the period required to close the diversion tunnel.

Three vertical-shaft units of 11,000 kw each make up the 33,000-kw power plant which is located across the river channel at the toe of the dam. For each unit a separate penstock of 5.5-ft diameter will be embedded in the dam.

The switchyard, located on the roof of the powerhouse, consists of three transformer bays and one bay for the outgoing lines. A 115-kv transmission line will be used for the initial phase of the project. A second stage of the power development entails construction of tunnels to take the discharge from the upper powerhouse and

FIG. 3. Multipurpose Karadj Project is most ambitious so far undertaken by Iranian Government. It includes powerhouse and concrete dam 610 ft high. See No. 4 on map, Fig. 1, and in Table I.


Karadj River
1600
1650
1675
1625
1650
1675
18 ft dia spillway tunnel
1700
1725
Emergency spillway
1750
Radial gates
1775
1800
El. 1757
El. 1755
1800
Radial gate
1750
1775
1725
1700
1675
Diversion tunnel plug
18 ft dia existing diversion tunnel
r=656 ft
Access road
1750
1775
1750
1725
1700
1675
1650
1625
1700
1725
1650
1675
1625
1625
1650
1675
Powerhouse
5.5 ft dia penstocks
Outlet pipes
Elevator tower
1650
1625
Normal water surface El. 1 765
50-ton gantry crane
Top of dam, El. 1 766
Gate hoist
Normal min water surface El. 1 720
Axis of dam
Trashrack structure
Fixed wheel gate
Min storage El. 1 691
El. 1 689
5.5 ft dia penstock
11 000 kw unit
Switchyard
El. 1 606
Foundation gallery
Section through penstock and powerhouse

Contours and elevations in meters

develop 754 ft of additional head. The tunnel outlet and the second powerhouse, of 60,000 kw, will be 8 miles downstream from the dam.

One of the major benefits of the Karadj Project is to store water for domestic purposes. The water is diverted downstream from the dam near Karadj into a steel pipe of 36-in. diameter and conveyed by gravity to the outskirts of Tehran, where it is filtered and passed through regulating reservoirs to the distribution system of the city. All the pipelines and the distribution system have been constructed over the past few years and will soon be ready for operation. Until now this city of over a million population has had no modern water distribution system.

There has been a shortage of power in Tehran for many years. The present 20,000-kw installation is a steam plant using oil as fuel. Many factories are planning expansion which will require additional power. The whole power distribution system will have to be revamped.

This project is a large undertaking, but the benefits to be derived from it will compensate for the capital outlay. The first stage, of 33,000 kw, will cost about $32,000,000 and is expected to be completed in 1958. To finish the project, the Iranian Government is seeking financial help from the Export-Import Bank of the United States.

5. Karkheh Project. For more than three years the Karkeh Dam and canals have been under construction, and the dam was completed in the fall of 1954. The work, started under contract, was completed by the Iranian Government with its own forces. This project is on the Karkheh River about 18 miles northwest of the city of Ahwaz in southern Iran. Designed by the Irrigation Corporation's engineers, it includes a concrete diversion dam about 20 ft high, with ten gates 15 × 19 ft, which stretch across the river for a distance of 615 ft. On the right bank there is a wing wall over 200 ft long. The water is to be diverted into two canals, one on each side of the river. That on the left is designed for a capacity of 1,760 cfs to irrigate 160,000 acres, and the smaller canal on the right has a capacity of 420 cfs for the irrigation of 38,000 acres.

6. Doroodzan Project. For the past three years studies and planning for the Doroodzan Project have been in progress. Plans and specifications for the dam and powerhouse are ready for contract adjudication as soon as financing can be arranged.

The Doroodzan Dam site is on the Kor River, 42 miles north of Shiraz. This river flows into another of Iran's salt lakes. Since ancient times, this area has been cultivated intensively and at one time was the center of Iranian civilization. There are large areas of arable land which require irrigation. Six masonry diversion dams, built about 500 years ago, and their irrigation systems, are still in use. Grain, sugar beets and rice are the principal crops at present, and there is a sugar refining plant in the area.

For the Doroodzan Project, it is proposed to build an earth dam 160 ft high to form a reservoir with 650,000 acre-ft of storage capacity. Major quantities for the dam are 5,250,000 cu yd of impervious material and 800,000 cu yd of rock fill, with 1,500,000 cu yd of impervious material in an upstream blanket extending 3,000 ft upstream. In addition, about 130,000 cu yd of sands, gravels, and crushed stone will be used for filters. At the dam site the river will be diverted through two tunnels of 23-ft diameter which will be used also to pass the flow of the existing Soon Canal during construction. This canal extends down the right side of the river for 6 miles and then splits into two branches. One branch crosses the river through a siphon. The right-bank canal extends for another 18 miles. It is planned to extend the left-bank canal for a distance of 54 miles, to below Persepolis. This left-bank canal picks up the dry-weather flow of the Main River, a tributary of the Kor. Estimated canal excavation is 8,800,000 cu yd, including the required distribution laterals.

Projects under investigation

There are several projects under active investigation for which final plans have not yet been completed. These include the Sefid-Roode, Karun River, Saveh, and Zarrineh-Roode Projects.

The proposed Sefid-Roode Project, No. 7 in Fig. 1 and Table I, is located on the Sefid-Roode River 50 miles upstream from Resht on the Caspian Sea. The average yearly flow of the river at the project is 5,460 cfs. The proposed concrete dam is 318 ft high and contains 475,000 cu yd of concrete. The reservoir will have a capacity of 1,500,000 acre-ft. Power generation in the first stage will be 10,000 kw, and in the second stage 20,000 kw. The project will supplement irrigation to 150,000 acres of presently cultivated rice land and will provide irrigation water for 150,000 acres of additional land, according to preliminary reports.

Most important of Iran's rivers is the Karun, which has a drainage area of 19,300 sq miles and flows into the Persian Gulf. A diversion dam on this river to divert water to the Khuzistan Plains is under study. Preliminary reconnaissance surveys have been made for a large storage reservoir on the upper reaches of the river to provide for flood and irrigation storage. It is estimated that 1,250,000 acres of land can be irrigated from such storage, and that many more acres can be put under cultivation with drainage and lowering of the water table through flood protection. There have been several disastrous floods in the Khuzistan Plains. The Karun is the most important in Iran for irrigation purposes (No. 8 in Fig. 1 and Table I).

For some years it has been planned to build a storage dam at the site of an ancient rubble masonry dam at Saveh on the Gharachay River (No. 9 in Fig. 1 and Table I). Diversion tunnels have been under construction for several years. However, because of troublesome foundation conditions, no conclusion on the design has been reached. The abutments are limestone with a river alluvium of sands and gravel 90 ft deep. Recently it has been proposed to build a rock-fill dam requiring 460,000 cu yd of rock fill, and rising about 230 ft above the present valley floor. Such a dam would provide 81,000 acre-ft of storage in the reservoir.

Preliminary studies of the Zarrineh-Roode Project in northeastern Iran (No. 10 in Fig. 1) indicate that a storage reservoir on the Zarrineh-Roode River above Miyondaub would provide sufficient irrigation water for the area. The Zarrineh-Roode is subject to wide fluctuations in discharge as it carries peak floods in the winter and has practically no flow during the summer months.

Two other projects have received some preliminary investigation but are not now being actively investigated. The Lar Project, northwest of Tehran (No. 11 in Fig. 1) contemplates the construction of a concrete gravity dam in the Lar gorge with a 72,000-kw power installation. This dam would divert the flow through a tunnel to the Jajirud Valley, where another reservoir would be created by a rock-fill dam to provide an additional 72,000 kw of ultimate capacity. The diverted water would be used for irrigation above the plains of Tehran and in the Jajirud Valley.

A similar project (No. 12 in Fig. 1) would divert the Taleghan River through a tunnel $4^{1}/_{3}$ miles long to the plains above Kazvin for irrigation.

During recent years, despite financial handicaps, studies for these various projects have progressed, and construction will be started as soon as financing can be arranged. The scope and extent of these projects is an indication of Iranian enterprise.

Civil engineering —a career

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Civil engineering as a profession is broad and well matured. It is the oldest engineering profession practiced and our Society is the oldest of the Founder Societies. As regards its breadth, consider that almost everything which is made by man and which stays in a fixed location has been to some degree the work of the civil engineer. His work differs from other branches of engineering in that many of his projects are individually large and are not duplicated. Each fits a particular situation—for example, a dam, a large bridge, a large building, a major highway location, or a harbor. These structures contrast with such other engineering projects as automobiles, electric motors, chemicals, and the production of metals from ores.

A broad general division between civil engineering and the other branches of engineering is that the other engineers are usually concerned with manufacturing and mass production, whereas civil engineers are not, except in special cases. One such special case was the participation of civil engineers in the design of aircraft structures—a natural phenomenon because of their training in stress analysis.

Instead of dealing with mass production, the civil engineer most often deals directly with people, generally in their capacity as members of public bodies. Instead of working for a company, he is more often self-employed as designer or constructor—a factor which arises from the lack of duplication of his structures. He conforms to the limitations of and problems posed by environment. He does not make the environment in which he works. His work is a continual battle with Nature, which does not provide transportation facilities and other needs where, when, and as desired by the populace. Rather, Nature has created obstacles to such facilities. The job of the civil engineer is to overcome such obstacles by providing detours, working facilities, and living space around, through, over, under, or in them on an economical basis.

Of course there are exceptions to the foregoing, but time is short and we must deal in generalities. Anyway, it seems a good idea to examine the forest before we inspect each tree in detail. This approach follows the pattern of development of a project because it is necessary to define first the criteria which are to control the design or construction of a large project, before the details of design or construction are undertaken. If this is not done, the individual parts of the problem will not integrate smoothly into a useful, economical, and attractive finished project.

Three stages— embryo, adolescent, adult

The character of the results produced by civil engineers has been outlined roughly. Now let's look at the civil engineers themselves, again from a broad viewpoint. I believe that they can be divided into a relatively few groups for purposes of this discussion:

1. In the embryo stage the civil engineer is usually a student in college. He learns the character of civil engineering; has his mental faculties exercised; acquires a habit of methodical approach and a historical knowledge of how some problems have been solved in the past. Equally important, he should learn in college how to live and work with his fellow men as individuals and as groups and also something about the organization, financial, and tax problems of communities, states and countries. Let it be noted that college is not essential for such development. It provides only a quicker and easier way of acquiring knowledge.

2. Immediately after college the civil engineer enters an adolescent stage. Here, under the guidance of elders who have already acquired experience, he begins to apply his methodical approach in the solution of practical problems. He learns perhaps for the first time, unless exceptionally well taught previously, that a practicing civil engineer does not just select arbitrarily loads, forces and materials, perform mathematical gymnastics with a slide rule and present his quantitative answers. Unlike the problems in a test or final examination in college, which are almost invariably formulated for him, his problems in real life consist mainly in getting properly ready to use his theory or to begin construction. In other words, he now has to search out what is known, what is unknown, and relate these according to expected natural, mathematical, and human phenomena in a manner consistent with the desired end result. Only then is his problem formulated. The very last step in actual design practice, that of mathematical calculation and making of drawings, is the one too often most emphasized in college. It happens also to be the one that is least important in separating the engineers from the technicians. Unfortunately, colleges have been slow to teach construction methods.

3. With his training completed and certain experience gained in practice, the civil engineer enters an adult stage. If he is to advance, he must continue

an active acquisition of knowledge; learning rather than memorizing is to be emphasized. In general he may follow any one of several fields:

- Teaching or research in the educational field
- Planning
- Design
- Construction
- Operation
- Management

Each field has technical subdivisions in large variety and each offers opportunities at a full range of levels.

Civil engineering—a service

In any one of the fields the young man should remember that civil engineering is a service and is not an end in itself. Actually, this is true of all professions—for example: law and medicine. One big difference between the three is that the major roll of civil engineering has been to provide facilities for added development and to create new buildings in which to live and work and new arteries of travel from place to place. Law and medicine devote more time to correcting than to creating.

We might examine briefly another characteristic of civil engineering as a career—a characteristic that has particular significance at the present time.

Civil engineering grew out of military engineering a long time ago—at a time when wars were waged largely with brute force and awkwardness. Today diplomatic procedures, which still in most of the world are no better than before our nation was born, aided and abetted by a runaway technology, are absorbing too much of the efforts of other engineers. It is the civil engineers who follow after the battles to restore sanitary facilities, housing, transportation and industrial plants. It cannot be said that the civil engineer is isolated from the awful potential of the modern gadgets of destruction, but at least he is primarily concerned with the accessories for peaceful living.

Wide diversity of services

The professional civil engineer performs his service by utilizing his specialized experience and judgment in the solution of problems for others who do not possess the needed technical ability because they are in other lines of work. In carrying out his service, the civil engineer frequently becomes a representative of his client and assumes responsibilities beyond the purely technical aspects. The proper exercise of such responsibility in *each one* of the general fields mentioned before is the hardest facility the civil engineer must acquire. It is the reason for codes and canons of ethics, and it gives rise to much confusion as to an adequate definition of professional practice.

I for one do not believe that any code or specification or law can outline in sufficient detail all the diverse services and responsibilities which a truly professional engineer must provide or undertake.

Recognition based on ability

Registration under a law will not cause you to be recognized as a professional man any more than will the acquisition of a driver's license. Legislation is regulatory rather than creative and in a measure provides a certain amount of protection. Neither will unionism, if that ever happens, enhance the professional reputation of civil engineers. Its logical result will be to degrade rather than to upgrade.

"By your deeds they shall know you" was never truer than for a civil engineer. If he discloses real ability, his opportunities are unlimited, his recognition for performing a truly professional service, the sufficiency of his income—above all, his satisfaction in a job well done—will follow automatically.

I know there are those who do not share the views just expressed. Many embryo and adolescent engineers desire professional status and large salaries but aspire to clockwatching and security. I have never hired a young engineer who during an interview exhibited primary concern about guarantees of such items. I readily consider that a generation of getting things for nothing, in an environment saturated with the idea that the world owes one a living, aids and abets loss of human dignity and dims the fundamental but rigorous ideas about work and thrift.

Nevertheless, I submit that the best way to acquire complete long-life security, with a minimum of work, is to arrange for a commitment to jail for life without possibility of pardon. Those who overemphasize a guaranty of security can have it. They are not and never will be engineers in the true professional sense.

To the young man I would like to give the idea that if he does his job properly every civil engineer is a consultant. The individual client may differ, the degree of responsibility may vary over a wide range, but the fundamental aspect of the service to be performed remains the same.

A few definitions

Let me leave with you some definitions contained in a publication of the American Institute of Consulting Engineers, the membership of which consists largely of civil engineers:

Engineering: the art of organizing and directing men, and controlling the forces and materials of nature, for the benefit, convenience, welfare, and use of the human race.

A Professional Engineer: one whose business is the expert and judicious application of science and technology to the solution of engineering problems.

A Consulting Engineer: one who, through special training, broad experience, proven ability, and professional integrity, brings to his client technical advice of the highest quality in the fields where he practices as an expert.

Engineers: their services have advanced the well-being of mankind; their talents have been devoted to the development of a richer and more enduring civilization.

A Pledge: "I will not henceforward suffer or pass, or be privy to the passing of, bad workmanship or faulty material in aught that concerns my works before men as an engineer, or in my dealings with my own soul before my Maker."

Causes of failure

Now, a word of caution and then I will cease to lecture.

Dun and Bradstreet, after studying thousands of business failures in 1953 have concluded that 90 percent resulted from human error. They classified these human errors as caused by: lack of ability, 55 percent; lack of experience, 45 percent. Furthermore, nearly 60 percent of all failures occurred during the first five years of the enterprise. Although I could find no similar study relating to individual civil engineers falling short of their desired goals, it seems reasonable to speculate that those same causes might be found to account for similar large percentages of individual failures.

It would seem to be good business for the young civil engineer to study most diligently and to obtain as wide an experience as possible during his first five years after college, even at the expense of a modest financial sacrifice. Such expenditures will prove more fruitful than investments in various highly tooted bootstraps advertised by gold-brick artists as self-lifting.

(This paper was originally presented by Mr. Timby before the Conditions of Practice Session at the ASCE Annual Convention in New York. This session was sponsored by the ASCE Committee on Junior Members and the Metropolitan Section's Junior Branch, with Jewell M. Garretts, chairman of the Committee, and Eugene D. Jones, president of the Branch, presiding.)

EARTH-FILL DAM

adds large capacity to San Joaquin storage

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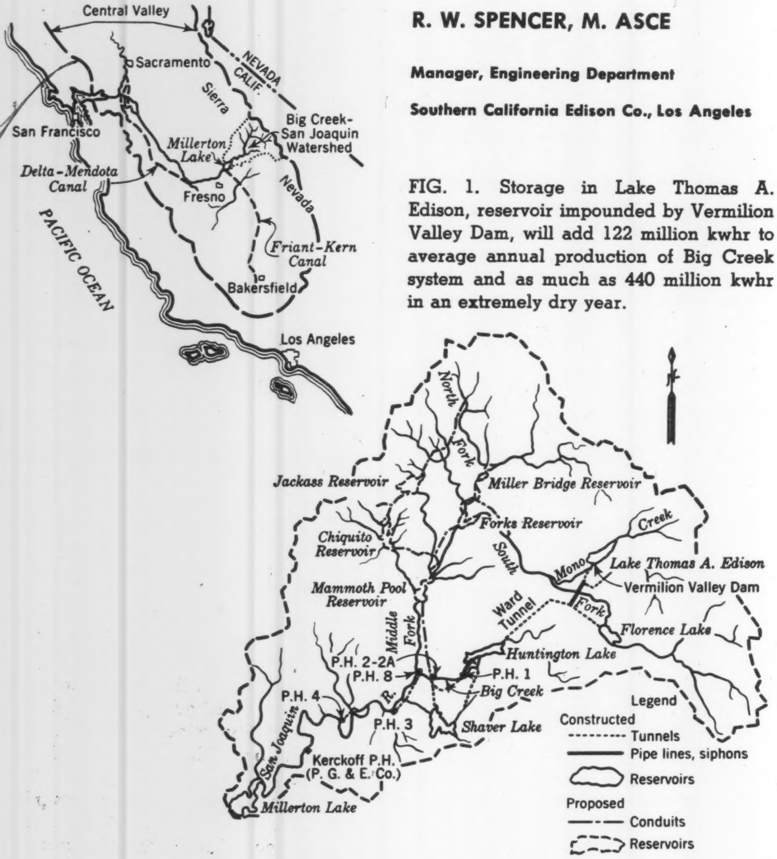

Central Valley
Sacramento
NEVADA
CALIF.
Sierra
Big Creek-San Joaquin Watershed
San Francisco
Millerton Lake
Delta-Mendota Canal
Fresno
Nevada
PACIFIC OCEAN
Friant-Kern Canal
Bakersfield
Los Angeles
North Fork
Jackass Reservoir
Miller Bridge Reservoir
Forks Reservoir
Chiquito Reservoir
South
Mono Creek
Lake Thomas A. Edison
Vermilion Valley Dam
Mammoth Pool Reservoir
Ward Tunnel
Fork
Middle Fork
R.
Florence Lake
Huntington Lake
P.H. 2-2A
P.H. 8
P.H. 1
Big Creek
P.H. 4
San Joaquin
P.H. 3
Shaver Lake
Kerckoff P.H. (P. G. & E. Co.)
Millerton Lake
Legend
Constructed
Tunnels
Pipe lines, siphons
Reservoirs
Proposed
Conduits
Reservoirs

FIG. 1. Storage in Lake Thomas A. Edison, reservoir impounded by Vermilion Valley Dam, will add 122 million kwhr to average annual production of Big Creek system and as much as 440 million kwhr in an extremely dry year.

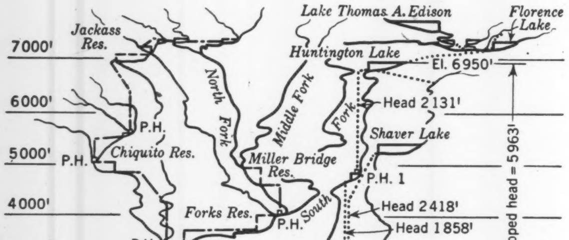

Lake Thomas A. Edison
Florence Lake
Jackass Res.
7000'
Huntington Lake
El. 6950'
North Fork
Middle Fork
Fork
6000'
Head 2131'
P.H.
Shaver Lake
5000'
P.H.
Chiquito Res.
Miller Bridge Res.
P.H. 1
Total developed head = 5963'
4000'
Forks Res.
P.H.
South
Head 2418'
Head 1858'
3000'
P.H.
P.H.
P.H. 2
P.H. 2A
Mammoth Pool Res.
San Joaquin R.
Head 713'
P.H. 8
Head 827'
2000'
P.H. 3
Kerckoff Res. (P. G. & E. Co.)
Head 416'
Dam 7 Res.
1000'
Kerckoff P.H.
P.H. 4
El. 987'
0'
Millerton Lake

FIG. 2. Schematic profile of Big Creek-San Joaquin River development indicates interconnection of units to secure maximum benefits to system as a whole.

Since the overall cost of the Vermilion Project is more than $8,500,000, the question arises as to what justification there is for such an expenditure. The drainage area controlled by the reservoir is relatively small, and no additional power-generating facilities are required in connection with this project—a part of Southern California Edison Company's Big Creek hydroelectric development in the High Sierra.

To understand the reasons for the construction of the reservoir and the method of its operation, it is necessary to review briefly the hydroelectric developments of the Southern California Edison Co. on the San Joaquin River.

Last November, the 125,000 acre-ft reservoir formed by the Vermilion Valley Dam was dedicated as Lake Thomas A. Edison, in honor of the great pioneer in the electric power industry. The addition of the reservoir increases the San Joaquin River basin storage constructed by the Southern California Edison Company to 440,000 acre-ft, about equal to the 434,000 acre-ft of usable storage provided by the Bureau of Reclamation at Friant.

Development of hydroelectric power on the San Joaquin River was contemplated more than fifty years ago by John S. Eastwood and others, but the first actual construction work was begun in 1911. Two powerhouses, Nos. 1 and 2, developing a total head of approximately 3,900 ft, were constructed on Big Creek, a large tributary entering from the south. (See Figs. 1 and 2.) At the same time, storage of 30,000 acre-ft above powerhouse No. 1 was provided by constructing the first stage of the three Huntington Lake dams. Some years later the dams were raised to provide 88,000 acre-ft of storage.

In the period from 1917–1929 the project was further developed by constructing three additional power plants Nos. 2A, 3 and 8, and two additional storage reservoirs at Florence Lake and

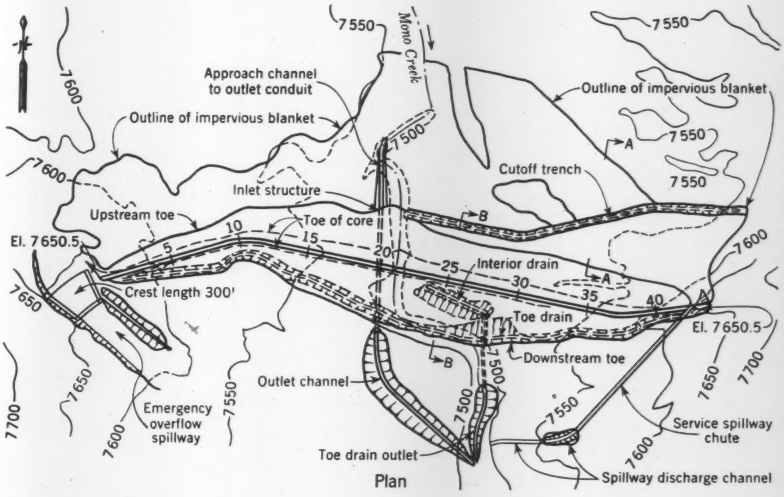
Shaver Lake of 65,000 and 135,000 acre-ft capacity respectively.

In 1925 the 13$^1/_2$-mile Ward Tunnel was completed to divert the headwaters of the South Fork of the San Joaquin into Huntington Lake. Pipeline and tunnel conduits were also built to divert Mono Creek, Bear Creek, and several smaller streams into the Ward Tunnel, thus increasing the water supply to the whole chain of power plants. The project on a whole was made economically feasible by the fact that it was possible to tap the headwaters of these streams at a high elevation and transfer them to the relatively few locations where storage could be developed. Without such storage, hydroelectric development in central and southern California is not economical because approximately 75 percent of the stream flow comes in about four months of the year. Even such a major stream as the San Joaquin River will, under natural conditions in the late summer and fall, drop to a flow of 150 cfs where it emerges from the foothills into the Central Valley.

The capacity of the Big Creek Project was further increased in 1948 by the addition of a fourth unit to powerhouse No. 3 and by construction in 1951 of a 92,000-kw plant called Big Creek No. 4, which utilizes the 420 ft of head remaining between the tailrace of powerhouse No. 3 and the backwater from the Kerchkoff plant of the Pacific Gas and Electric Company, which in turn discharges into Friant Reservoir, constructed by the Bureau of Reclamation. This brings the total operating capacity of the Edison Big Creek–San Joaquin system to 530,000 kw, and the total head utilized by the company to just under 6,000 ft. The average annual output of the present system without the Vermilion Valley Reservoir is around 2.8 billion kwhr, ranging from a maximum of 3.9 to a minimum of 1.2 billion kwhr.

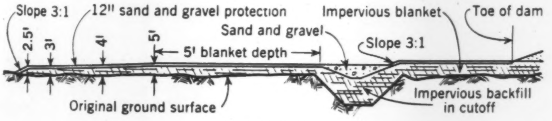
It should be mentioned that the foregoing average annual output figure is based on the 30-year stream-flow record from 1905 to 1935, which is believed to represent the long-time sequence of wet and dry conditions on the San Joaquin

Upstream face of Vermilion Valley Dam, completed in October 1954, is powdered by first snowfall. Zoned type of earth structure, with impervious core and long upstream apron, was made necessary by character of foundation and available fill.

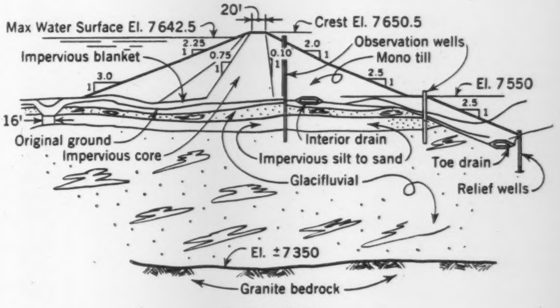

7550
Mono Creek
7550
7600
Approach channel to outlet conduit
Outline of impervious blanket
Outline of impervious blanket
7500
A
7550
7600
Cutoff trench
7550
Inlet structure
Upstream toe
Toe of core
B
El. 7650.5
10
15
5
20
25
Interior drain
30
A
35
40
7600
7650
Crest length 300'
Toe drain
El. 7650.5
B
Downstream toe
Outlet channel
7500
7500
7550
7650
7700
7700
7650
7600
Emergency overflow spillway
7550
7600
Service spillway chute
Toe drain outlet
Spillway discharge channel

Plan

FIG. 3. In Vermilion Valley Dam, on somewhat pervious foundation, provisions for ample drainage are important. They include highly pervious zone downstream from core, reverse filter toe-drain running full length of dam, and extensive system of gravel-packed wells draining into toe-drain. Note also long, impervious upstream apron.


Slope 3:1
12" sand and gravel protection
Impervious blanket
Toe of dam
2.5'
3'
4'
5'
Sand and gravel
5' blanket depth
Slope 3:1
Original ground surface
Impervious backfill in cutoff

Section A-A


20'
Max Water Surface El. 7642.5
Crest El. 7650.5
2.25
1
0.75
1
0.10
1
2.0
1
Observation wells
Impervious blanket
Mono till
3.0
1
2.5
1
El. 7550
2.5
1
16'
Original ground
Interior drain
Impervious core
Impervious silt to sand
Toe drain
Glacifluvial
Relief wells
El. ±7350
Granite bedrock

Section B-B

Clearing operation, called "high-balling," involved use of ball of 8-ft diameter. Even a large tree toppled when "high-ball," pulled by two tractors, rode part way up trunk.

River. It is apparent from the variation in kilowatt-hour production that the wide range in water supply makes it desirable to build up holdover, or so-called cyclic storage, from wet years into dry years not only to furnish additional kilowatt-hours but also to protect the peaking capacity of the plants.

Prior to April 1953, long-time contracts with irrigation water users limited the company to 43,000 acre-ft of storage at the beginning of the runoff season and to a total of 288,000 acre-ft of storage at any time. The prime reason for the limitation in storage on the San Joaquin was the desire of a few water users to protect their appropriations of high flood flows. By 1938 most of these water rights had been acquired by the U. S. Bureau of Reclamation, and with the construction of Friant Reservoir, where the river leaves the foothills, it seemed likely that additional headwater storage might be advantageous to all water users.

In April 1953, a joint agreement was reached between Edison, the Bureau of Reclamation, Miller and Lux, and the Associated Canal Companies which permitted additional storage in a reservoir to be constructed on Mono Creek subject to certain limitations. The Southern California Edison Company agreed, among other things, that a minimum of 40,000 acre-ft of storage would be held for use in extremely dry years—estimated to occur about three times in a 30-year period.

Selection of the dam site on Mono Creek was determined by the physical fact that Vermilion Valley provided the only relatively flat area in the drainage basin where economical storage could be had. The site had been considered in the 1920's but abandoned because diamond drilling showed that the granite or basalt bedrock was covered with up to 250 ft of glacial debris. At that time the art of earth-dam construction had not advanced to a point where a structure of this type would be feasible with the available fill materials and type of foundation. In the 1940's the problem was restudied in the light of modern advances in earth moving and soil mechanics.

New studies prove advantageous

Much additional exploratory work was done by drilling, test pitting, and seismographic work. Designs were made for storage dams of various sizes from 20,000 to 180,000 acre-ft. Since the mean annual runoff of Mono Creek averages 114,000 acre-ft and varies from a minimum of 38,000 acre-ft to a maximum of 194,000 acre-ft, it was evident that water would not be available to fill a very large reservoir after a drawdown to the bottom. It was also found that the cost of a small-capacity reservoir was unreasonably high per acre-foot.

The studies indicated that a capacity of around 125,000 acre-ft was most economical considering that some annual storage was desirable to prevent the spills which occur every year at the diversions of Mono and Bear Creeks, and also considering that the new reservoir would provide more economical space for holdover storage than any other site on the system. It is also economical from the water conservation standpoint because at El. 7600 the annual loss from evaporation is only 43 percent of that at Friant Reservoir at El. 600.

Spill that could be economically salvaged was found to average about 25,000 acre-ft per year. This was made up of spill at three points—Mono Creek Diversion, Bear Creek Diversion, and Florence Lake Reservoir. It is true that water cannot be transferred physically from Bear Creek and Florence Lake to Vermilion Valley, but by storage of the high flows of Mono Creek in Lake Thomas A. Edison, water now spilled can be diverted from Florence Lake and Bear Creek into the other reservoirs of the system.

The economical amount of water to be saved was found by routing stream flows predicted from snow surveys in late winter and spring through the various conduits, reservoirs, and powerhouses. Usually several operating methods were examined. In this manner it was determined that the average annual addition to the kilowatt-hour production of the Big Creek System would amount to about 122 million kw-hr, and as much as 440 million kwhr in an extremely dry year.

In addition to the value of the average annual kilowatt-hour addition to the system output, a value had to be placed on holdover storage for use in extremely dry years. It was found that this could be done most certainly by studying the generating system of the Edison Company as a whole, including steam generation in the metropolitan area, and the company's share of the Hoover Dam energy both under present conditions and again after the addition of the new reservoir. This is a complicated procedure but generally consists of taking present and predicted load curves of the system and fitting into those curves, in the most economical manner, all the company's generating plants. In this manner it was found that the addition of Lake Thomas A. Edison would be equivalent to adding approximately 76,000 kw of new steam generation to the entire company system, in addition to the average annual production of 122 million kwhr.

At present-day prices, the additional steam capacity might be expected to cost about $11,000,000, so it is apparent that the expenditure for the Vermilion Dam and Reservoir was well justified. The finding that the project was economically feasible, and the agreement with the water users on the method of operating the reservoir, then permitted the engineers to take up the equally difficult problems of designing and constructing the dam.

Dam design and construction

Since the dam was to be founded largely on deep glacial moraines and glacio-fluvial material, and since material in the glacial debris near the dam site is relatively coarse, a zoned type of dam was selected. An impervious core and an apron extend upstream from the dam to increase the length of the path of percolation through the foundation.

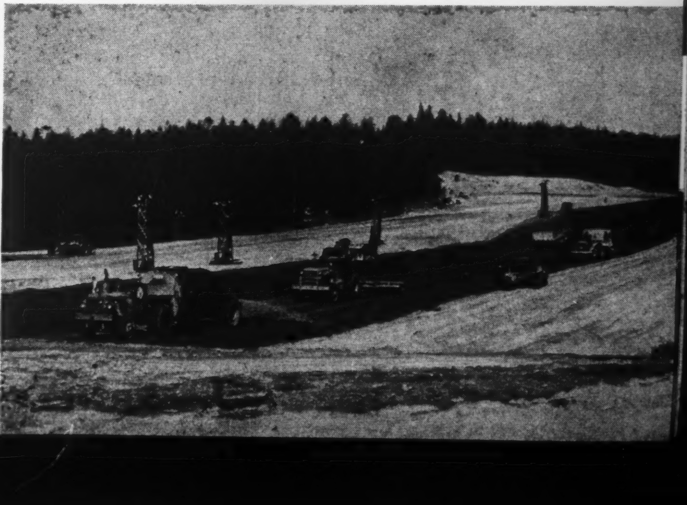
To obtain the best economy in the design of any earth-fill dam, it is desirable to use whatever suitable native materials are available. In the case of Vermilion, the fine materials necessary for watertightness were found fairly close to the surface. Such materials were underlain by coarse sand and fine gravel. Extensive laboratory tests before construction showed that in general the tightest material for core use was obtained by mixing the top 18 in. of silty sand and soil with from 1 to 4 ft of relatively porous sand and gravel. Such material was found generally in meadows and flats one to two miles upstream from the dam in the reservoir area.

Construction operations were arranged so that the maximum amount of mixing and moisture conditioning took place in the borrow areas. Pervious material was found in great abundance in sand and gravel alluvial deposits within the reservoir area.

Another major consideration in the design of an earth dam on a more or less pervious foundation is to provide ample drainage in such a way as to preclude all risk of piping or sliding. In the Vermilion Dam this was accomplished in three ways (Fig. 3):

1. By providing a highly pervious zone of sand and gravel downstream from the core.
2. By providing a reverse filter toe-drain, consisting of washed sand, gravel, and cobbles. This toe drain extends the full length of the dam and is set well down under the downstream toe.
3. By providing an extensive system of gravel-packed wells which drain into the toe-drain system. These wells have depths of from 30 to 80 ft, and are arranged to relieve any possible hydrostatic pressures in the deep foundations of the dam. They were carefully developed by surging and pumping.

The Bechtel Corporation was engaged to design and construct the dam, and some of the best consulting engineers available were retained. Among the



Impervious material loaded in borrow area by push-cat (at top) and by Sierra Loader (center), is placed in impervious core above old Mono Creek stream bed (bottom).

Concrete service spillway (looking upstream) is provided with control gate structure, in middle distance.

consultants were Dr. Karl Terzaghi, Hon. M. ASCE, Donald W. Taylor, A.M. ASCE, Dr. Ian Campbell, and Julian Hinds, M. ASCE.

Construction work on the job began in May 1953 and continued until November of that year, when the project had to be shut down because of the normal heavy snow at that high elevation. Work was resumed in April 1954 and the dam was dedicated October 19, 1954.

All dirt-moving operations were conducted by Bechtel Corp., on a 9-hour, two-shift basis working 6 days a week. Mechanics were put on a three-shift schedule in order to be available during all operations and to perform major servicing during the $4^1/_2$-hour shutdown between the end of the night shift at 1:00 a.m. and the start of the day shift at 5:30 a.m.

Comparatively shallow cuts were made in the borrow areas to utilize the fine surface layers for impervious core and blanket. The underlying pervious sands and gravels were limited only by depth to ground water or strata of fine sand and silts.

Two Sierra Loaders were purchased as the best type of equipment for loading out the impervious material. Drawn by a tractor, with all controls handled from the tractor by a single operator, a loader was found to be capable of excavating along a vertical face up to 5 ft in depth and by means of a 48-in. elevating belt conveyor, loading out a 20-cu yd DW-20 scraper unit in about one minute. Particularly important was the fact that the vertical cut fed onto the belt afforded a considerable degree of blending of the material in the initial loading. The scrapers, in this instance, were used only as hauling units.

In the pervious sections of the borrow areas, the DW 20's were generally loaded as scrapers with the help of one or two pushers, depending on the type and compaction of the pit material. Production was comparable to the Sierra Loader but involved more and harder wear on the scraper and tractor equipment. Operations naturally varied during the season. At times, both shovels and dump trucks were used for borrow-pit excavation. In such cases, the shovels were spotted in areas where embedded boulders in the gravel deposits interfered with the other types of loading. The trucks were also used occasionally as hauling units from the Sierra Loaders.

During the peak production month of September, slightly over 600,000 cu yd of compacted embankment was placed in the dam and blanket area. This was at a time when both shovels were available for borrow-pit operations. Equipment used strictly for borrow-bit excavation and hauling during this period included a Manitowoc No. 3500 and a Northwest No. 80 shovel, eight Kenworth dump trucks, two Sierra Loaders, an average of fifteen DW-20 scraper units, and four International TD 24's used as pushers.

Embankment placing followed conventional procedure. The 6- to 8-in. layers of material were disked and bladed to get the required amount of blending of moisture and material. As most of the embankment was placed by DW 20's, a minimum amount of bulldozer spreading was required. As far as practicable, water was added at the borrow pits by 5,000-gal water wagons or a semi-portable sprinkling system set up near available water. Additional water was added on the fill as required to secure maximum density.

Three 50-ton, rubber-tired articulated-wheel compactors were used for all embankment compaction. Two of these compactors, by the use of a recently designed gooseneck coupling, were powered by DW-21 tractor units. This combination resulted in greater maneuverability and pulling power over the conventional four-wheel tractor units, especially for the first passes over soft material.

For Bechtel, the Vermilion Project was under the general supervision of John R. Kiely, M. ASCE, Vice President. M. L. Dickinson, M. ASCE, Project Manager, was in charge of all design work, and K. O. Taylor was General Superintendent in charge of field construction.

For Edison, the project was under the general supervision of W. L. Chadwick, M. ASCE, Vice President. T. M. Leps, A.M. ASCE, Chief Civil Engineer, and O. N. Kulberg, Chief Construction Engineer, coordinated the design and construction, and H. A. Barber was Resident Engineer in the field.

(This article was originally presented by Mr. Spencer as a paper before a Power Division session presided over by Henry V. Lutge, Chairman of the Division's Executive Committee at the ASCE San Diego Convention.)

Outlet works in Vermilion Valley Dam is controlled by micro-wave radio from Big Creek Powerhouse No. 1.

R. D. KINSEY, M. ASCE, Assistant District Engineer
S. EVANS, District Landscape Engineer
District IV, California Division of Highways, San Francisco, Calif.

California's roadside vegetation killed with chemicals

For many years the State of California has carried out control of roadside vegetation for the principal purpose of reducing fire hazards to adjoining grazing lands. In recent years this work has been further increased to cover the control of vegetation around various safety devices and road signs.

Until recent years this vegetation control has required the repetition of work from year to year with little carry-over of the results from the previous work. To improve the type of control, the state has utilized various types of materials as they have been placed on the market and has improved the results over the years by the use of new materials.

The original method used to control the vegetation was spraying with diesel oil followed by burning, a method which was not entirely effective and which required repetition each year. This method also was considered a fire hazard since it was not always possible to carry out the burning operations at the proper time on account of the varying climatic conditions found in this state, where rainfall varies from 5 to 70 in. per year and where the season is of varied length, with some spring and summer rains.

To overcome the disadvantage of the diesel oil and burning method, the first chemical used extensively was sodium chlorate. This material readily forms a solution when 1 lb is combined with 1 gal of water. The solution is then sprayed on the roadsides. This method does develop a certain amount of sterilization of the soil with the result that the first application of $^{1}/_{5}$ gal per sq yd can be reduced when additional applications are needed as conditions dictate. This material is hazardous to use because, when combined with vegetable matter, it produces a cellulose which is explosive and has been known to ignite spontaneously. It also requires careful handling to avoid injury to operators. One of the principal advantages of sodium chlorate is that it is effective in controlling weeds and grass without harm to trees and heavy shrubs.

To avoid the hazards of sodium chlorate, a product combining sodium chlorate with borates was placed on the market. This product, because of the fire retarding characteristics of the borates, greatly reduced the fire hazard of the sodium chlorate. These chemicals must be applied on the ground surface, a condition requiring a considerable clean-up of the area prior to application, and in many cases requiring the further refinement of washing in the solution to make it reach the roots.

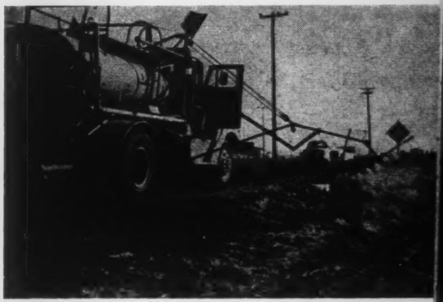
A recently developed compound, chlorophenyl dimethylurea, called "Telvar W," which has just been placed on the market, has been used extensively this past season along the highways in the San Francisco Bay area. This material has several outstanding advantages in that it is not hazardous from the standpoint of fire or harmful to the personnel applying it, and it can be applied regardless of ground conditions. It is applied in a solution composed of 13 lb to 50 gal of water, spread over one roadside mile 4 ft wide, as compared to the 350 lb of sodium chlorate and 350 gal of water required under the former method. Thus there is a considerable saving in cost due to the saving in time required to spread the material.

The use of the new material this first season appears to warrant its continued use for further testing since the type of kill appears to be considerably above our previous experience. At present, however, we have no definite experience as to the effective life of the material and its selective toxicity; that is, it may present hazards to certain trees and shrubs adjoining the treated strip.

Our soil sterilants are applied with both tank trucks and tree sprayers. Since agitation is necessary during mixing, the application equipment used must be capable of providing it. Sodium chlorate, being readily soluble, requires much less agitation than Telvar W, which is not soluble and requires vigorous agitation to maintain a uniform mixture. The material is generally applied at a pressure of approximately 40 psi; a high pressure is not desirable as it would produce fogging and resulting wind drifting.

The material is spread on the roadsides by use of a T-bar on the end of a 6-ft length of pipe equipped with a quick shutoff valve. The T-bar is equipped with 80-deg fan spray tips. This equipment, in the form of lever arms, is supported by an arrangement of pulleys and ropes so that the spray operator can maneuver it from the truck seat while the vehicle is in motion. Sodium chlorate is spread at the rate of 350 gal per mile and at a speed of 3 to 5 miles per hour on a uniform fire control strip 4 ft wide. Telvar W is spread at the rate of 50 gal of solution per mile on the fire strip at a speed of 10 miles per hour. At locations where obstructions are present, the speed naturally must be

Spreading truck used by State of California in San Francisco area for roadside weed control has 1,000-gal capacity and is equipped with agitator. Note that spray is delivered from T-bar on end of 6-ft pipe, which can be maneuvered by operator.



Roadside on a state highway in Marin County, California, following application of "Telvar W."

reduced to approximately 5 miles per hour.

In applying these materials, careful consideration must be given to climatic conditions and to coordination of the application with seasonal rainfall. It is important that the material be applied so as to take advantage of the lighter rainfalls of the season to help carry it into the soil, but extreme caution should be exercised so that the material will not be applied in seasons when heavy rainfall will carry it below the root zones. Where rainfall is light, this refinement is not so important.

From the limited experience we have had up to the present time, it appears that Telvar W is retained in the upper part of the ground surface in sufficient quantity to attack the later germination of dormant seeds. Only time will determine what can definitely be expected in regard to its retarded action.

With the material being applied in the early winter or rainy season, it has generally not been necessary to provide for an advance clean-up of the area to be treated, since the winter season generally will destroy the weeds of the previous season by weathering action. There may be occasional locations where the nature of the dry weeds may be such as to make a clean-up necessary. If the weed growth is heavy, it would be desirable to remove it before applying the soil sterilant, since the application will then be more readily available to the new weed growth at the ground surface.

Our experience indicates that the cost in place of this new material is about the same as that of sodium chlorate. The true cost of placing Telvar W cannot be evaluated until we have had more experience with its use.

ENGINEERS' NOTEBOOK

Final end moments for single-span beams

LEONARD O. HOPKINS, Jr., M. ASCE, Structural Engineer, Nashville, Tenn.

An accurate and rather simple solution for determining the final end moments for a single-span beam, for any combination of distribution factors and carryover factors, utilizes a variable coefficient which is a function of the product of these four factors. The method can be best explained by considering the general example shown in Fig. 1.

The following terms are used:

Knowns:

M_{FA} = fixed-end moment at A
M_{FB} = fixed-end moment at B
d_A = moment distribution factor $\overline{AB}$
d_B = moment distribution factor $\overline{BA}$
c_A = carryover factor $\overline{AB}$
c_B = carryover factor $\overline{BA}$
N_A = $d_A c_A$
N_B = $d_B c_B$

Unknowns:

M_A = final end moment at A
M_B = final end moment at B
C = coefficient to be determined
M_{TA} = total moment at A
M_{TB} = total moment at B

A common form for setting up computations to determine the total moment at each end of the beam is shown in Fig. 1. Following this form, the final moment at A, for example, can be computed as,

$$M_A = M_{TA}(1 - d_A) \quad . \; . \; . (1)$$

$$M_{TA} = (M_{FA} + M_{FB}N_B) \times (1 + N_AN_B + N_A^2N_B^2 + N_A^3N_B^3 + N_A^nN_B^n) \quad . \; . (2)$$

Letting the second term be called C,

$$M_A = C(M_{FA} + M_{FB}N_B)(1 - d_A) \quad . (3)$$

The coefficient C, it is noted, is equal to 1.0 plus the summation to the nth power of the products of the distribution factors and the carryover factors used at each end of the beam. C may also be expressed as

$$C = \frac{1.0}{1.0 - N_AN_B} \quad . \; . \; . (4)$$

This equation can be inserted in Eq. 3, which gives a resulting formula for the final moment at A, as

$$M_A = \frac{(M_{FA} + M_{FB}N_B)(1 - d_A)}{1.0 - N_AN_B} \quad . (5)$$

Similarly, the final end moment at B is

$$M_B = \frac{(M_{FB} + M_{FA}N_A)(1 - d_B)}{1.0 - N_AN_B} \quad . (6)$$

Example illustrates method

M_{FA} = 12.0 ft-kips
d_A = 0.70
c_A = 0.60
N_A = $0.70 \times 0.60 = 0.42$
M_{FB} = 16.0 ft-kips
d_B = 0.40
c_B = 0.50
N_B = $0.40 \times 0.50 = 0.20$
$N_A \times N_B = 0.084$

$$M_{FA} = \frac{(12.0 + 16.0 \times 0.20)(1 - 0.70)}{1.0 - 0.084} = \frac{15.2 \times 0.30}{0.916} = 4.9782 \text{ ft-kips}$$

$$M_{FB} = \frac{(16.0 + 12.0 \times 0.42)(1 - 0.40)}{1.0 - 0.084} = \frac{21.04 \times 0.60}{0.916} = 13.782 \text{ ft-kips}$$

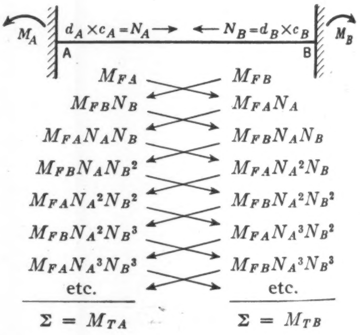


FIG. 1. Computations for determining total moment at each end of beam are set up in a common form.

THE READERS WRITE

The world's great rivers

To the Editor: In the December issue of Civil Engineering, page 31, mention is made of the discharges of rivers, taken from a fascinating book, *Earth's Grandest Rivers*, by Ferdinand C. Lane. This book is really very interesting, but the data on discharges are acknowledged by Mr. Lane to be inaccurate, and for many rivers they are missing.

Using recent data available to me, and by integration of runoffs from parts of drainage areas, after making various reductions and adjustments, I have found the values for average annual flow of the large rivers of the world to be as follows:

No.	River	Flow, in cfs
1	Amazon	4,070,000
2	Congo	1,375,000
3	Yangtse Kiang	1,147,000
4	Ganges with Brahmaputra	868,000
5	Paraná	750,000
6	Mississippi	642,000
7	Yenissei	615,000
8	Mekong	559,000
9	Lena	547,000
10	St. Lawrence	534,000
11	Orinoco	495,000
12	Irrawaddy	473,000
13	Ob	442,000
14	Niger	425,000
15	Amur	388,000
16	Volga	283,000
17	Magdalena	265,000
18	Mackenzie	251,000
19	Columbia	240,000

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Surge-tank equation corrected

To the Editor: I appreciate the fine editing and careful redrawing of the figures for my article, "Simplified Computation of Surge-Tank Action," in the February issue, p. 63. Unfortunately, an error has been slipped into the basic Eq. 5, p. 64. The last quantity, +1, should have been included under the radical sign. The correct form of Eq. 5 is

$$H_2 = N + M\Delta t^2 \left(1 - \sqrt{\frac{2N}{M\Delta t^2} + 1}\right)$$

This error is obvious, but may be confusing to some who want to use this equation in computations for surge tanks.

Harold Tults
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Chicago, Ill.

American engineering education—how good is it?

To the Editor: Mr. Volse's impressions of the standards of engineering education in France (November 1954 issue, p. 65) bring out the deficiencies in engineering education in America as well as in other countries.

The foundation for the "solid mathematical background" of French engineers is laid in their secondary schools. It is at this level that American standards could be raised by increasing the number of high school years by one or two. This extra time would also provide greater opportunities for the study of non-technical subjects.

One of the most important impressions visiting Australian professors and lecturers bring back from America is the low standard of undergraduate courses in American universities. An Australian professor of mathematics who spent a semester at a Pacific Coast university and a semester at a Southern university said that in America the standard is designed to meet the requirements of the average student, whereas in Australia the standard is set for the honor student.

It is almost universally admitted by the above mentioned critics that American postgraduate schools are of a high standard, and provide adequate facilities for advanced training in engineering.

In Australia a number of technical colleges train engineers over a period of five years by offering mainly evening courses, and grant diplomas. Degree courses, of a high standard, are offered at most Australian universities. The emphasis is on fundamental subjects rather than on applications. Practising engineers are invited to lecture on their specialized fields, and third-year students are expected to do six months of practical work. Despite their limited resources and facilities, Australian universities attempt a considerable amount of research work.

Of perhaps greater importance to American engineers than a higher standard in mathematics is a broader training in the humanities, which will enable them to understand the problems of the countries to which they are sent by various international agencies or by their own government.

The enormous amount of research work coming out of American universities is proof that there is not much wrong with the present standards of engineering education.

Z. J. Buzo, M. ASCE
Consulting Engineer

Armidale, New South Wales, Australia

Non-destructive highway testing again used

To the Editor: Experiments similar to those described in the January issue in the News Brief item entitled "Dynamic Road-Testing Method Demonstrated" (p. 80), have been made and published by the undersigned. The references are:

1. Discussion of the paper, "The Application of Geophysical Methods to Grading and Other Highway Construction Problems," by E. R. Shepard, Proceedings of the 16th Annual Meeting of the Highway Research Board, Nov. 1936, Vol. 16, pp. 288–293.
2. Discussion of the paper, "Stresses on Concrete Pavement Slabs," by M. G. Spangler and F. L. Lightburn, Proceedings of the 17th Annual Meeting of the Highway Research Board, Dec. 1937, Vol. 17, pp. 230–233.
3. "Highway Investigations by Means of Induced Vibrations," Engineering Experiment Station, Bulletin No. 49, The Pennsylvania State College, Vol. 33, Oct. 1939.
4. "Geophysical Study of Soil Dynamics," Transactions of American Institute of Mining and Metallurgical Engineers, Geophysics, Vol. 138, 1940, pp. 326–344.

In all cases, a two-mass mechanical oscillator excited sinusoidal vibrations, and seismic pick-ups in combination with an oscillograph recorded the induced deflections of the highway. Propagation wave velocity in the pavement, modulus of elasticity, and stresses could be determined from these records. The instrumentation used in these investigations was developed in this country. A similar system was applied in 1933 by the "DEGEBO" in Germany.

It is gratifying indeed that this non-destructive testing method has been used again with satisfactory results.

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New Brunswick, N.J.

Should design be based on ultimate strength?

To the Editor: The article by Robert L. Ketter and Bruno Thürlimann, "Can Design Be Based on Ultimate Strength?" in the January issue, was an extremely interesting and well presented compilation of information on the subject of ultimate strength "analysis" and design. The writer believes, however, that a further examination of their examples will show that ordinary construction may profit little by the ultimate strength theory beyond the 20-percent stress increase for negative moments which is now present in the AISC code.

It is interesting to compare designs on the authors' two-span beam example with the concentrated loads placed in their much more usual positions at the center of each 20-ft span. Elastic analysis results in a negative moment of 188 ft-kips at the center support.

$$S = \frac{188 \times 12}{24} = 94.$$ An 18WF55 is required [AISC 15(*a*) (3)]

Using the authors' ultimate strength derivations for this case:

$$S = \frac{1.88 \times 50 \times 120 \times 120}{1.14 \times 33 \times 360} = 100.$$ An 18WF60 is required.

The required beam weights are now just the reverse of the authors' case—in the favor of *present* design methods. In further consideration of problems of this type it should be noted that *deflection* is often the controlling feature of continuous beam selection, as in highway bridges with continuous stringers and depth limited for clearance.

It is even more interesting to compare designs on the authors' rigid-frame example. The writer analyzed the given frame by customary elastic methods, and his design was based on a close observance of the present AISC specification. This resulted in a permissible design using a 12WF27 for both beam and columns—identical with the authors' proposed ultimate strength solution. The elastic approach requires investigation of the rigid-frame joint—especially if a uniform factor of safety is to be achieved. But it is to be noted that the ultimate strength approach *assumes* that the joint can remain relatively rigid under full plastic moment—a most difficult thing to achieve under usual framing and architectural clearance conditions.

The fabrication of connections which are capable of sustaining assumed moments is the little-mentioned weak link of ultimate strength analysis. There has been considerable research indicating that much care must be taken in evaluating moment vs rotation capacity of structural-steel rigid-frame joints. (See "Design and Research for Welded Structures," by LaMotte Grover, ASCE Proceedings Separate No. 343, Nov. 1953, pp. 343-17, and the writer's discussion of same, Sept. 1954). However it should be mentioned that there is little if any available research on this subject with respect to reinforced-concrete rigid-frame joints constructed according to some of the ordinary reinforcement splicing practices.

Norman B. Jones, J.M. ASCE
Structural Engineer
Whittier, Calif.

Factor-of-safety concept needs clarification

To the Editor: The article, "Can Design be Based on Ultimate Strength?" in the January 1955 issue, by Robert Ketter and Bruno Thürlimann is most welcome. It is a good thing to remind the practicing engineer that a simpler, safer, and more economical design method is available. How long will the inertia of the profession force us to waste both the client's money and our own time—and to create inferior structures to boot?

There is one consideration that could have been brought out more clearly in an article as basic as this. That is the concept of the factor of safety. Dead loads can be computed exactly; live loads have to be guessed. Dead loads will be as located by, and of the magnitude prescribed by our drawings—but almost anything can happen as far as live loads are concerned. Just think of a grand piano being dropped on a floor designed for 40 psf, or the common tendency of all crane operators to try to pick up everything and anything they can get a hold on.

Applying a factor of safety of 1.88 or 2.5, or anything any code prescribes, to dead load allows for our inability to compute more exactly. In all modesty, unless we displace the decimal point, we should be able to do better. But the same factor of safety applied against the grand piano or the crane operator might be catastrophic.

Applying a factor of safety for total load—and this happens when operating with "allowable stresses"—is quite meaningless. For example: two structures are designed for a so-called factor of safety of 1.88 for total load. The first carries a 75-percent live load and a 25-percent dead load. The real factor of safety for overloading by live load is (188 − 25)/75 = 2.17. The second structure carries a 25-percent live load and a 75-percent dead load. The real factor of safety for overloading by live load is (188 − 75)/25 = 4.52. That is, the second structure is more than twice as safe as the first.

Design based on ultimate strength will automatically correct this anomaly, because the load factor of safety will be different for dead load and live load.

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Project Engr., Paul Rogers
and Associates
Chicago, Ill.

Does bulb-end pile become end-bearing?

To the Editor: In the December 1954 issue, there is an interesting article by J. H. Thornley, M. ASCE, on the use of compressed concrete pedestal piles installed under the New York City Building Code providing for non-end-bearing piles of 60-ton capacity each.

The question arises as to whether or not a bulb-end pile does practically become an end-bearing pile. In that event, information taken from the article would tend to show that the 30-in.-dia bulb ends would transmit approximately 12 tons per sq ft to the soil if the piles were loaded to 60 tons. This unit pressure on the soil appears to be extremely excessive, considering that even though the soil is compacted under pressure, the benefit gained from compaction would soon be dissipated.

Also, the likelihood of obtaining a concentric bulb under the pile is questioned. While the photos in the article reveal uniformly good results, there are many who have seen photographs of exposed bulb-end piles with the bulbs eccentric and the shafts quite constricted and not uniform.

There seems to be no positive way to ascertain the true condition of this type of pile without testing each one.

Bernard F. Locraft, M. ASCE
Washington, D.C. *Civil Engineer*

Some misunderstandings as to non-end-bearing piles

To the Editor: I have read the letter from Bernard F. Locroft commenting on my article on the Corlears Hook foundations in the December 1954 issue. Mr. Locroft seems to have a most unusual viewpoint as to the basis of the bearing values developed by special foundations in general and by non-end-bearing piles in particular. If piles of all types carried no more load than could be developed by surface spread footings having an area equal to the point sections of the piles, an extremely large percentage of non-end-bearing pile jobs would totally fail to support the structures founded on them. I know of no modern code or departmental specification—whether city, state or federal—or any recent book such as the massive work on *Pile Foundations* by Robert D. Chellis, M. ASCE (McGraw-Hill, 1951), which even considers rating the bearing value of a driven pile on the basis of end dimensions and surface soil values.

In order for a pier, caisson, or pile of any type to settle under load, there must be a rearrangement of the soil particles to make way for the downward movement of the bearing member. This movement may be preceded by consolidation where the soil is such that water can be driven out under an increase in pressure. Where the bearing member is a pile which has been driven into the soil, that soil will have been compacted by the operation of driving and the soil readjustment will have been still further inhibited.

Other elements increase the bearing value of a pile as compared with that of a spread footing. One of these elements is friction on the shaft of the pile. Where the concrete is driven into the soil by means of high pressure and impact, as in the case of the compressed concrete pile, the friction developed between pile and soil is likely to produce a very substantial potential bearing value. The idea of measuring the bearing value of the bulb by assuming the pedestal to act as would a spread footing of equal area, at the ground surface, certainly would not occur to anyone familiar with the operation of driving pedestal piles. The idea behind this type of pile is that a sandy soil of medium bearing value may be changed into one of very high bearing value by consolidating and compacting it with driven pedestals.

Getting away from theories, however, the unanswerable argument in this case lies in the pile tests which showed a 100-percent overload. This is not a case based on a single test but on a dozen tests scattered over a large site. Under twice the proposed loading, that is to say, under a pile load of 120 tons—not 60 tons—the settlements did not, in a single test, even approach the permissible limit.

Mr. Locroft makes the strange statement that "the benefit gained from compaction (of the soil) would soon be dissipated." "Compaction" of a sandy soil arises from the rearrangement of the soil particles. Occasionally, in the case of finely divided soils such as inorganic silts, *consolidation*, not compaction, may be subject to a time lag because it takes time to permit the water to seep away through the small spaces between soil particles. Outside of cases where the pile bearing was developed in a clay soil, we have never known of a foundation settlement traceable to the breaking down of a false soil-water pressure. I think it can be stated as a universal rule that outside of clay soil bearings, *all* piles increase in bearing value with time.

Mr. Locroft points out the possible lack of concentricity of the pedestal and the pile shaft. If the pedestal is formed by pressure transmitted axially through the shaft, then the pedestal will be and should be in the position and of the shape to resist this forming pressure. Any other shape would be less efficient in resisting the load which will be transmitted to it axially by the shaft.

J. H. Thornley, M. ASCE
President, Western Foundation Corporation
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"Slope distribution" or "moment distribution"?

To the Editor: In his article, "Continuous Beams Analyzed by Slope Increments," in the December 1954 issue (p. 66), Prof. F. A. Wallace demonstrates a method of simultaneous moment and slope distribution. This procedure, however, introduces unnecessary complications. It is elementary knowledge of beam theory that any change in slope produces a change in end moment and vice versa. Therefore, any moment "distribution" at a joint, obtained by "releasing" that joint, will produce changes in slope.

The writer fails to see how the author's cumbersome method of simultaneous dis-distribution of slopes and moments helps to clarify the physical picture. If "slope distribution" is thought to be preferable to "moment distribution," the former can easily be accomplished by the following procedure without a concurrent moment distribution:

1. Assume all joints hinged; the structure then becomes a series of simply supported beams.
2. Determine the end slopes of all these simple beams.
3. Actually, all slopes at a joint must be equal; therefore, distribute the slope unbalances at each joint in proportion to the inverse stiffness factors L/I.
4. Carry over slopes to the far ends of all members; the carry-over factor equals minus one-half. Repeat the procedure until all joints are balanced.
5. Then use the slope deflection equations to obtain all end moments from the slopes.

This method involves the same amount of work as does moment distribution, plus the additional Step 5.

If the author intended his method to be used for the primary purpose of obtaining slopes, this can easily be accomplished through the Hardy Cross method. It does not require the solution of simultaneous equations, as the author stated.

If a moment M is applied to the near end of a simply supported beam, the slope at the near end is $ML/3EI$, at the far end $ML/6EI$. If θ_o denotes the slope at the end of a simply supported beam due to transverse loads, the slope θ at the support of a continuous beam is given by

$$\theta = \theta_o + M_nL/3EI - M_fL/6EI$$

where M_n and M_f are the moments at the near and far ends of the beam, respectively. These moments are made up of fixed-end moments, *FEM*, and moment changes, ΔM. Hence

$$\theta = \theta_o + FEM_nL/3EI - FEM_fL/6EI + \Delta M_nL/3EI - \Delta M_fL/6EI$$

The first three terms of the right-hand side add up to zero, for the fixed-end moments are defined as the moments which prevent any change in slope due to transverse loads. The slope at any continuous support is therefore given by

$$\theta = \Delta M_nL/3EI - \Delta M_fL/6EI$$

where $\Delta M_n = M_n - FEM_n$, and $\Delta M_f = M_f - FEM_f$. The author's illustrative example (Fig. 2) is used in the computations given in Table I.

The stiffness factors *k* and fixed-end moments *FEM* are taken from the author's Fig. 2. The final moments *M* are obtained by the usual moment distribution procedure. The final slopes, θ, are obtained by subtraction of the two preceding lines. This last line provides a check on the entire moment distribution which, unfortunately, was lost in the author's procedure.

Harold G. Lorsch, A. M. ASCE
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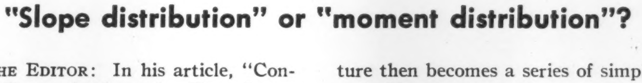
The City College of N. Y.
New York, N. Y.

TABLE I. Computations for slope deflections



$k = I/L$	0.5		2.0		3 0		2.67	
FEM	−50	+120	−20	+75	−25	−80	−20	0
Final moment *M*	−59	+102	−102	+19.5	−19.7	−26	+25.6	
$\Delta M = M - FEM$	−9	−18.1	−82.1	−55.5	+5.3	+54	+45.6	
$\Delta M_nL/3EI = \Delta M_n/3k$	−6	−12.1	−13.7	−9.25	+0.57	+6.0	+5.7	
$\Delta M_fL/6EI = \Delta M_f/6k$	−6	−3.0	−4.62	−6.85	+3.02	+0.3	0	
Final slope θ	0	−9.1	−9.08	−2.40	- 2.45	+5.7	+5.7	

Aluminum cross arms on aluminum towers

To the Editor: The otherwise excellent paper by W. G. Huber, M. ASCE, entitled "Kemano-Kitimat Transmission Line Built to Resist Heavy Ice and Wind Loads," in the January issue, is misleading as regards the aluminum towers. The article is in error in respect of the line drawing and photograph captioned as Fig. 2. The box-girder cross-arms for the aluminum towers were designed and fabricated in aluminum, not in steel.

F. L. Lawton, M. ASCE
Chief Engineer, Power Dept.
Aluminum Laboratories Ltd.
Montreal, Canada

Editor's Note: The drawings were mislabeled through no fault of Mr. Huber. An excellent article on the details of the basic conception, design, and erection of the aluminum towers for the Alcan Nechako-Kemano-Kitimat Development, of which Mr. Lawton is a joint author, was printed in the November issue of The Engineering Journal, published by the Engineering Institute of Canada.

SOCIETY NEWS

San Diego Section Host to Memorable Society Convention

The San Diego Section set out to do a superlative job of entertaining the ASCE Convention held in San Diego the week of February 7, and that it did. In fact the only complaint heard among the 1,000 members, guests, and students gathered for the week-long technical and social program was that all too soon it would be necessary to leave Southern California's balmy (75-deg) temperature and head back to the Arctic reality of February in other parts of the country.

Robert K. Fogg headed the Convention committee, whose conduct and organization of every detail of the program has been universally remarked. Especially commended was the speed and efficiency of the bus service that taxied members back and forth between the headquarters hotel and beautiful Balboa Park, where some of the events were held.

President Glidden Speaks

At the Wednesday morning Welcome Session, visitors were greeted by Section President William J. Bobisch, Vice-Mayor Charles B. Wincote, and James A. Robbins, chairman of the San Diego County Board of Supervisors. In an address entitled "Employment Conditions and Leadership," President William Roy Glidden discussed the "perennial" problem of the disparity of engineers' earnings "compared with the earnings of others in employment requiring much less preparation and knowledge." He pointed out that, "When any group in our social order secures a specific advantage in the matter of compensation in any form (unless a corresponding increase in productivity results), the gains are at the expense of the balance of the general public."

No other professional engineering society, Mr. Glidden said, "has been as alert as ASCE to the problem [collective bargaining] or has expended so much constructive effort in the guidance and protection of its members." He summed up the Society's stand on collective bargaining which he defined as a "Declaration of the Three Freedoms for Professional Employees." These "Freedoms" are:

Executive Secretary and Mrs. Carey (top photo) admire the silver bowl, a gift from the Board of Direction, presented to them at the Wednesday Membership Luncheon. Middle view shows Rear Admiral John R. Perry, Chief of the Bureau of Yards and Docks, giving the featured address at the Friday Award Luncheon. Pictured at the head table at the Wednesday luncheon (lower left) are Mrs. Walter Huber: Maj. Gen. Samuel D. Sturgis, Jr., Chief of Engineers and principal speaker; Secretary Carey; and Mercel J. Shelton, ASCE Director for District 11. In lower right photo Comdr. C. W. Capwell exchanges greetings with San Diego Section President W. J. Bobisch (left) and Convention Chairman Robert K. Fogg, who filled the two jobs Commander Capwell himself had when the Society had its last Convention in San Diego in 1941.

Past-Presidents of the Society attending the Convention with their wives pose with the present President and the Executive Secretary and their wives. They are (in usual order) Past-President and Mrs. Walter Huber, Past-President and Mrs. Daniel V. Terrell; President and Mrs. William R. Glidden; Executive Secretary and Mrs. William N. Carey; Past-President and Mrs. Carlton S. Proctor; and Past-President and Mrs. J. C. Stevens.

"1. Freedom to form and administer independent bargaining units.

"2. Freedom from association with a bargaining unit which includes non-professionals.

"3. Freedom to employment unconditioned by membership in a bargaining unit."

Mead Prize Awarded

Another feature of the Wednesday morning session was the award of the Daniel W. Mead Prize for Juniors to Alfred E. Waters, II, J.M. ASCE, of Los Angeles. Dean Francis M. Dawson, member of the Board of Direction, conducted the ceremony.

General Sturgis' Address

In a talk on "The Role of the Engineer in the Federal Government," that highlighted the Wednesday Membership Luncheon, Maj. Gen. Samuel D. Sturgis, M. ASCE, Chief of Engineers, emphasized the difficulty of attracting young engineers to the Corps as a career. "In spite of the greater-than-ever need for competent engineers, the government is steadily losing ground in its struggle to compete for the services of the professional engineer," he said. He added that, "Unless something is done to meet the government's problem, America is surely heading for an unacceptable decrease in its relative security and a serious, if not mortal, impairment of its economic advancement."

To prove his point, General Sturgis said that recently at Thule he discovered that his project engineer, "a lieutenant-colonel in charge of building this $250,000,000 Arctic air fortress entailing the solution of the most complex engineering and construction problems, was receiving considerably less pay than the table waiters working in the contractor's mess."

Secretary Carey Honored

Of special interest at the Membership Luncheon was the presentation of a plaque to Executive Secretary Carey, who is retiring in May, and of a silver bowl (the gift of the Board of Direction) to Mr. and Mrs. Carey. President Glidden referred to Mr. Carey as "unanointed leader of the Society, who has earned a plaque heretofore reserved for Presidents on the completion of their service." Mr. Glidden also spoke feelingly of the "charm and tact that have characterized Mrs. Carey's contributions to Secretary Carey's outstanding success and to the Society's interests."

Admiral Perry Speaks

Against the impressive background of the great San Diego Naval Base, Rear Admiral John R. Perry's talk on "The Engineer and the Navy"—featured at the Friday Award Luncheon—took on special meaning. Admiral Perry, who is chief of the Navy Bureau of Yards and Docks, emphasized that "maintaining our Navy shore establishment is our big job," and said that "the day of engineering with an eye toward maintenance is rapidly approaching." He added, "It will affect each of you, although you may be employed strictly in design or construction. The constructor who perfects his techniques to minimize the deteriorating effects of the elements will not go hungry for work. Certainly, paths would be beaten to the door of the designer who could come up with a maintenance-free facility." Admiral Perry's talk is abstracted elsewhere in the issue.

Student Prizes Awarded

Giving its name to the Award Luncheon was the ceremony of presenting prizes to winners in the student paper contest, an annual feature of the Pacific Southwest Student Conference. Winners out of a field of twelve, carefully culled by their Chapters in preliminary contests, were Thomas E. Difloe, of the University of Arizona, who received first prize for his paper on the "Mississippi-Atchafalya Di-

Shot taken at the Award Luncheon (lower left) shows Section President and Mrs. W. J. Bobisch; Admiral John R. Perry; and ASCE Vice-President Mason Lockwood, who is about to present first prize in the student paper contest to Thomas Difloe, of the University of Arizona (standing, right foreground). Second prize winner, Douglas Tingley, of the University of New Mexico, stands behind Mr. Lockwood. In right-hand view President Glidden presents the Daniel W. Mead Prize for Junior Members to Alfred E. Waters, II, of Los Angeles. Dean Francis M. Dawson, member of the Board of Direction, is at the right.

AMERICAN SOCIETY OF CIVIL ENGINEERS FOUNDED

Interesting reunion group at the Convention shows ASCE Director Thomas C. Shedd (seated, center) with some of his former students at the University of Illinois, where he is professor of structural engineering. At Professor Shedd's right is Dean Harold E. Wessman, of the University of Washington College of Engineering, and at his left William H. Wisely, Associate Secretary of ASCE. Standing are W. J. Bobisch, Newlin D. Morgan, Jr., Ernest Hartmann, Maurice Quade, and Harold T. Larsen.

Elmer J. Maggi (standing), of the Arizona Section, addresses the Local Section Conference that drew representatives from all the Western states during the San Diego Convention for enthusiastic discussion of many phases of Society operation at the local level.

version Problem," and Douglas Tingley, of the University of New Mexico, who was awarded second prize. Noel Adkins, of San Diego State College, was student M.C.

Compelling Technical Program

Possibly the cardinal interest of the meeting was the cardinal interest of the region—water. In the lobby of the headquarters hotel and wherever else engineers gathered, there was talk of underground water, surface water, and "sky water."

In a very effective Hydraulics Division presentation, Irvin M. Ingerson, A.M. ASCE, principal hydraulic engineer, California Department of Public Works, spoke without notes on "Measurement of Quantity and Salinity of Outflow from Sacramento-San Joaquin Delta." Supplementing his talk was a movie film of boat equipment for measuring salinity in the Sacramento–San Joaquin Valley. Mr. Ingerson declared that the average current meter is "no good," though the fixed flow meter may be used for flows of from 1 to 8 ft per sec. On the job in question the boat carrying the flow meter was moving forward with a speed that was measured and correlated to the flow-meter measurement, all controlled from transit stations on shore and ship-to-shore radio communication.

Exceptional interest was shown in sessions of the Engineering Mechanics Division, the Soil Mechanics Division, and the Surveying and Mapping Division. The high point of the Surveying and Mapping program was a film and discussion of the Univac machine, a fabulous electronic calculating device, which held the audience spellbound until well after half past five. Extremely popular, also, was the Sanitary Engineering Division program dealing with radioactive fallout and other problems of contamination breath-taking in their implication. Perhaps the high point of this session was Conrad Straub's paper dealing with sanitary engineering problems involved in handling radioactive waste. Mr. Straub is chairman of the Division's Committee on Sanitary Engineering Aspects of Nuclear Energy.

The high concentration of technical papers was not at the expense of professional subjects. Hitting its stride, the recently formed Committee on Conditions of Practice sponsored popular sessions on engineering education and collective bargaining in its relationship to the engineer. A paper on engineering education by Harvey Banks, a member of the Society's Special Joint Task Committee on Engineering Education, recommending a five-year course for engineers, received much favorable comment. A dissenting opinion was expressed by Harold Wessman, dean of the University of Washington College of Engineering, who favors a four-year course plus graduate work. In an informal discussion Dean Wessman told the Convention that the average engineering teacher is a good teacher and that his salary is sadly out of scale. Branding the condition a "disgrace to the profession," Dean Wessman urged the Society to help the situation. In his suggested five-year course, Mr. Banks would eliminate shop and practice courses and place more emphasis on scientific textbook courses.

Wide Press Coverage

Since San Diego is a major Naval base, words on defense preparation received more than passing attention. Navy personnel were numerous at the addresses of both General Sturgis and Admiral Perry. The papers dealing with problems of local and state concern also received wide attention. The press, which had been well alerted to the Convention by an energetic publicity committee, headed by Elwood A. Lawrence, gave the program extremely generous space. Both daily newspapers, the *Union* and *Tribune*, ran appreciative editorials on civil engineering, and a business-legal daily, the *Transcript*, devoted much of its front-page space to many of the papers. Radio and TV, too, were frequent and enthusiastic in their reports.

Engineering Wonders of Area

With enthusiasm for engineering running high, the Section announced its Seven Engineering Wonders: Palomar Observatory; the All-American Canal of Imperial Valley; Mission Bay Park, under development; Cabrillo Freeway; the Encina power plant of the San Diego Gas and Electric Company; El Capitan Dam; and San Diego Aqueduct.

Convention Smoothly Run

Two phases of a national Convention that sometimes run into minor difficulties are registration and the conduct of sightseeing tours and other social events. At San Diego both were smoothly handled. The registration chairman was Richard S. Holmgren. Philip W. Helsley headed up the entertainment committee, and Mrs. Robert K. Fogg, Ladies' Activities.

Variety of Trips Offered

The San Diego area has so many points of attraction that visitors were hard put to it to make choices. Inspection trips had been arranged to the Encina Steam Plant at Carlsbad, Calif., an aircraft carrier in the harbor, a demonstration at the casting yard of the Southwest Structural Concrete Corporation, and the Scripps Institute of Oceanography at La Jolla. The wind-up Friday evening saw a fleet of busses off to Tijuana across the border.

Two-Day Local Section Conference

Also of interest was the unusually well attended and stimulating two-day Local Section Conference, where one could find

Colorado talking to Sacramento and Arizona to Montana, telling each other what they do and don't do to make their branches of a great Society effective in the capillary areas. There seemed to be a definite trend toward recognizing the luncheon meeting as the best of all meeting devices. In the more densely populated areas, telephone teams are organized to supplement meeting notices. Other talk centered about the methods adopted of keeping the Student Chapters in closer contact with the Sections. Particularly effective was the talk on public relations by J. Byron Barber, president of the Spokane Section.

Actions of ASCE Board of Direction Briefed

Actions taken by the ASCE Board of Direction at its San Diego meeting, February 13 and 14, are abstracted below.

Districts and Zones

There being no requests from any Local Sections for changes in the boundaries of Districts and Zones, the Board took no action. However, the Committee on Districts and Zones submitted a statistical tabulation showing an encouraging picture of the changes in distribution of voting membership in the Districts and Zones. The tabulation will be printed in a later issue for the information of interested members.

APO Members

A change in the By-laws was received for first reading which, if approved at the next (St. Louis) meeting of the Board, would permit APO addressees and others in similar circumstances to remain assigned to their respective Local Sections and Districts, at the option of the member involved.

More Money to Local Sections Approved

Effective for the current fiscal year, the Board amended the By-laws to provide for the payment to Local Sections of a sum not to exceed $50, plus a sum not to exceed $50 for each Subsection or Branch of a Local Section, plus a sum not to exceed $25 for each Student Chapter and Branch Chapter within the jurisdiction of the Section, plus an amount based on the dues-paying membership of each Section.

Joint Committee on Spillway Capacities

Approval was given to the creation of a joint ASCE-AWWA committee for the study of the hydraulic capacity of spillways, and the capacity of channels downstream from spillways. The recommendation originated with a joint committee headed by Julian Hinds.

Program Committee Appointed

On recommendation of the executive committee of the Committee on Conditions of Practice, the Board appointed a Society Committee on Session Programs. The purpose of this committee is to cooperate with Local Sections and regional councils in the development of technical and professional programs for regional conferences and national conventions. Its personnel consists of Finley Laverty (chairman), California, term ending October 1955; Lawrence B. Feagin, Missouri, term ending October 1955; I. W. Santry, Texas, term ending October 1956; R. A. Hill, California, term ending October 1956; R. A. Marr, Virginia, term ending October 1957; Fred H. Rhoades, Jr., Washington, without term; Norman R. Moore, Mississippi, without term; Charles W. Yoder, Wisconsin, without term; and John F. Tribble, Alabama, without term.

Civil Service

After considering identical resolutions from several Local Sections favoring a return to the former "P" classifications for professional employees, and after considering a report of an investigation from Vice-President Frank L. Weaver, the Board decided that representation to the Civil Service Commission would be unlikely to be productive. The report will be published in April CIVIL ENGINEERING.

Admission of Associate to EJC Approved

The Board approved the admission of the American Institute of Industrial Engineers to Engineers Joint Council as an associate.

Committee on Engineering Education to Meet

A meeting of the Society's Committee on Engineering Education with ASCE representatives on Engineers Council for Professional Development (ECPD) was approved. It is scheduled for August in Milwaukee.

Sanitary Engineering Specialty Board

The Board considered a report of the Joint Committee for the Advancement of Sanitary Engineering, which was accompanied by proposed articles of incorporation for the proposed creation of "A Sanitary Engineering Specialty Board." The purpose of such a Board would be the certification of qualified sanitary engineers. The report concluded with the following three recommendations:

1. Approve the proposals of the Joint Committee for the Advancement of Sanitary Engineering discussed herein and record ASCE support of the certification of sanitary engineers.
2. Approve a loan in the amount of $7,500 to the proposed Intersociety Board to finance the initial steps of certification.
3. Agree to provide office space in the Engineering Societies Building and primary office equipment—desk, typewriter, table, chairs and files, without charge.

The Board received the report and accompanying material for study. It instructed the Executive Secretary to invite additional material from proponents of the plan and to invite a spokesman from the Committee for the Advancement of Sanitary Engineering to appear before the Board of Direction at its June 1955 (St. Louis) meeting. The Board also authorized the appointment of a Special Task Committee to study the proposal; to confer with the attorney for the Society on the matter; and to report to the Board of Direction at its June meeting giving particular attention to the three recommendations quoted above.

The Board of Direction instructed the Executive Secretary to express to the Joint Committee for Advancement of Sanitary Engineering its appreciation of the important and extensive work done on this subject, and the desire of the Board of Direction to work out a satisfactory solution to the problem in an across-the-table discussion.

Hastings Resolution

The Board proposed a memorial resolution honoring the memory of Past-President Edgar M. Hastings who died on November 24, 1954.

Engineering Societies Center Building

The Board considered the report of the Special Committee of Five Presidents, which recommended that Pittsburgh be selected as the location of the proposed Engineering Societies Center Building. The report stated that the recommendation was "based on the lowest capital cost and lowest annual expenditure" if built in Pittsburgh. The Board of Direction considered this recommendation to be "qualified" and voted to request the Committee of Five Presidents, with the assistance of an appropriate staff representative from each of the five Societies concerned, to restudy the problem considering *all* factors involved and to make a subsequent recommendation which would not be qualified.

Meeting in San Diego during the ASCE Convention is the Society's special highway committee assigned to study the requirements of President Eisenhower's road program. Reading clockwise around the table are ASCE Past-President Carlton S. Proctor, chairman (at head of table at right); former Vice-President George W. Burpee, of New York; Harmer Davis, director of the Institute of Transportation and Traffic Engineering at the University of California, Berkeley; Joseph H. Ehlers, ASCE Field Representative; Don P. Reynolds, assistant to the Secretary of ASCE; Ralph A. Tudor, of San Francisco, former Undersecretary of the Interior; former Vice-President Edmund Friedman, of Miami; and ASCE President W. Roy Glidden, assistant chief engineer of the Virginia Department of Highways and ex-officio member of the committee.

ESL Annual Report Summarizes Space Needs

Current interest in acquiring a new Engineering Societies Building has made the consideration of space needs important, according to the annual report of the Director of the Engineering Societies Library. The Library Board had already started to study the space requirements of the library when a request was received from the United Engineering Trustees, Inc., to investigate the possibility of reducing the Library's requirement to 10,000 sq ft in a new building. In response to this request, a committee made an extensive study of the matter and prepared a report which was unanimously approved by the Library Board, and transmitted to UET.

The findings of the report are believed to be of long-range importance to the Founder Societies, UET, and the library. Some main points of the report were:

1. In new quarters specifically designed for library use, the space now used for the library reading room, offices, and staff workspace might be reduced.
2. Despite this possible saving, the collection of books and periodicals would have to be reduced 68 percent if only 10,000 sq ft were available.
3. The cost of microfilming 68 percent of the collection would be prohibitive—about a million and a half dollars, in addition to which operating costs would be increased.
4. Special space-saving equipment of the drawer and hinged-shelf type is expensive, unsatisfactory, and a definite safety hazard.
5. Cooperative storage facilities for library books are available in only a few areas in the United States. Even where available, it would be impracticable to store 68 percent of the collection at a distance from the Library.
6. If 68 percent of the books in the present collection were to be discarded, the library no longer would be outstanding. No longer would it be a primary source of information and service for the profession. Other engineering libraries would then surpass it in size, but none have the collection, the organized information, and trained and experienced staff required to give service to the engineering profession equal to that now provided by the ESL.
7. The Committee could see no nondestructive means of housing the ESL in 10,000 sq ft.
8. The Committee concluded that in view of the value of the library's outstanding collection and its services to the engineering profession, space should be provided for the present collection and services, and for growth. It was estimated that up to 1980, about 26,600 sq ft would be required.

Overall use of the library increased during 1953–1954. There was a great increase in orders for bibliographies because of the issuance of a new "Bibliography on Filing, Classification, and Indexing Systems for Engineering Offices and Libraries." The number of books borrowed dropped sharply because of the Library Board's action last year discontinuing the lending of periodicals. A change in the closing time from 10 p.m. to 9 p.m. has apparently inconvenienced few engineers using the reading room.

During the year 16,817 visitors were served, and 21,278 non-visitors. Answers were provided to 9,349 telephone inquiries and to 4,786 written inquiries. Other services included 127 paid searches and translation of 260,335 words. Staff activities also included the preparation of reviews of books valued at $3,700 for the benefit of the four Founder Societies, the Engineering Institute of Canada, and the Engineering Index.

J. Waldo Smith Hydraulic Fellowship Offered Again

Availability of another $1,000 award for a student engaging in one academic year of full-time graduate study in hydraulics is announced by the ASCE Committee for the J. Waldo Smith Hydraulic Fellowship. Applications should be routed through the institution at which the research will be undertaken. The engineering faculty at the institution will cooperate in the administration of the fellowship, and will receive up to $400 for equipment.

Applicants should be less than 30 years old and either an Associate or (preferably) a Junior Member of ASCE. The recipient cannot accept other appointments or part-time jobs during the academic year. Other conditions of administering the fellowship are given in the current ASCE Official Register. It will be noted that the project proposed should be in the field of experimental, as distinguished from purely theoretical, hydraulics, with the purpose of developing a better understanding of fluid flow. A complete comprehensive report of the research undertaken must be sent to the Executive Secretary of ASCE before August 31, 1956.

Applications should be submitted to Hunter Rouse, Chairman, J. Waldo Smith Hydraulic Fellowship Committee, State University of Iowa, Iowa City, Iowa, before May 1, 1955. They should include three copies of a summary of the applicant's training, experience, and personal data, with a recent photograph and outline of his proposed research project; three copies of a letter from the department head appraising the applicant's qualifications for the project; one transcript of his academic record; and a letter from the dean or similar officer certifying that the applicant is eligible for full-time graduate study and that the proposed project has administrative approval.

New England Council of Sections to Meet in March

The Connecticut Section will be host to the second regional conference of the New England Council of Sections, to be held at the Statler Hotel, Harford, Conn., Saturday, March 26. In conjunction with this regional conference, the Society is planning a two-day Local Section Conference at the Statler for March 24 and 25. Invited delegates from throughout the Northeast will attend the Local Section Conference, the first ever scheduled independent of a Society Convention.

Registration for the meeting of the New England Council is set for 9 a.m. in the ballroom foyer. There will be no registration fee for Student Chapter members; to all others the fee will be $1.25. Tickets for the luncheon ($2.50) and dinner ($4.00) may be purchased at the time of registration. If all three tickets are purchased at the same time a "package" price of $7.50 is offered. The luncheon meeting will be addressed by President Glidden, and the dinner meeting will be addressed by President Glidden, and the dinner meeting by Carleton F. Sharpe, city manager of Hartford. Both are scheduled for the Statler's Buffalo Room—the luncheon at 12:30 p.m. and dinner at 5:30. The ladies' program will start with a Get-Acquainted Hour in the ballroom foyer at 10 a.m. and go on from there.

The technical program will include a session on the Greenwich-Killingly Expressway, beginning at 10 a.m.; a session on "Pollution Abatement in New England," beginning at 2 p.m.; and a session on "Community Planning in New England," beginning at 3:15 p.m. All will be in the Hartford Room.

Reservations for lunch and dinner should be forwarded to Earl R. Howard, President, New England Council, ASCE, 115 Broad Street, Hartford, Conn., to reach him not later than March 15. For those wishing to stay overnight, reservations should be made directly with the Statler.

Column Research Council

Attention is called to several inaccuracies in the item, "Column Research to Yield Safer, Cheaper Structures," in the January issue (page 67). The Council has its headquarters at 101 Park Avenue (Room 407), New York 17, N.Y., and not at the Fritz Engineering Laboratory, Lehigh University, which is the headquarters of the secretary, Robert L. Ketter. The reference to "Fritz Engineering Laboratory" in the caption for the photo should be omitted, as the investigation of column strength is being carried out at Purdue University.

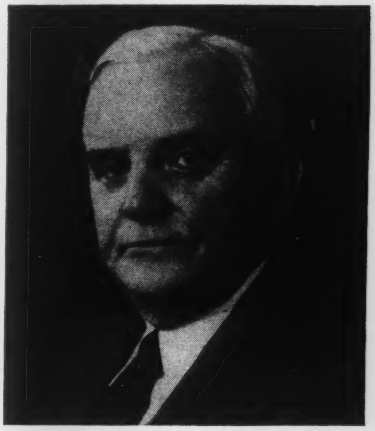
ASCE Honorary Member Brehon Somervell Dies

Brehon B. Somervell, 1892–1955

Brehon Burke Somervell, head of Koppers Company, Inc., and retired four-star general in charge of the Army Service Forces during World War II, died at his home at Ocala, Fla., on February 13, after a long illness. He was 62. General Somervell had been a member of ASCE since 1925 and Honorary Member since 1942.

An honor graduate of the U.S. Military Academy at West Point and of the General Staff School at Fort Leavenworth, Kans., he was in the Corps of Engineers from 1914 until his retirement from the Army in 1946. In World War I he was with the Fifth Engineers, the first American Engineering outfit to land on the continent, receiving the Distinguished Service Cross for a reconnaissance behind German lines in the Meuse-Argonne offensive. His notable peacetime jobs included an assignment as head of the Works Progress Administration in New York City. Under his direction, the WPA built La Guardia Airport and did numerous other construction jobs from which the city still benefits. As commanding general of the Services of Supply (later called the Army Service Forces) from March 1942 through the end of World War II, General Somervell had the task of supplying armies around the world. The first engineer officer in the United States Army to achieve the rank of four-star general, he took part in the "Big-Three" Conferences at Casablanca and served in many other administrative capacities. General Somervell was born in Little Rock, Ark.

C. B. Burdick, Hon. M. ASCE, and Former Officer, Dies


Charles B. Burdick, 1874–1955

Charles B. Burdick, long a partner in the Chicago consulting firm of Alvord, Burdick, Howson, and an Honorary Member of ASCE since 1947, died on February 17 after a short illness. He was 80. Though Mr. Burdick's entire career centered about Chicago, where he was born, he had done work for several hundred cities in most of the states and for several foreign countries. He was a pioneer in water treatment by mechanical filter, and his office designed more than 100 filtration plants, including some of the largest in the world. It has also designed sewage-treatment plants for a variety of conditions.

Mr. Burdick's development of the fundamental principles involved in the collection of underground water, as illustrated by the country's largest infiltration gallery installation at Des Moines, Iowa, has been another important contribution. His studies of floods, their occurrence and their control, made him an outstanding authority in that field, too.

Becoming an Associate Member of ASCE in 1905 and a Member in 1911, Mr. Burdick served as Director from 1935 to 1937 and as Vice-President in 1941 and 1942. He was an honorary member of the American Water Works Association and the Western Society of Engineers as well as of ASCE. He was a graduate of the University of Illinois.

NOTES FROM THE LOCAL SECTIONS

(Copy for these columns must be received by the tenth of the month preceding date of publication.)

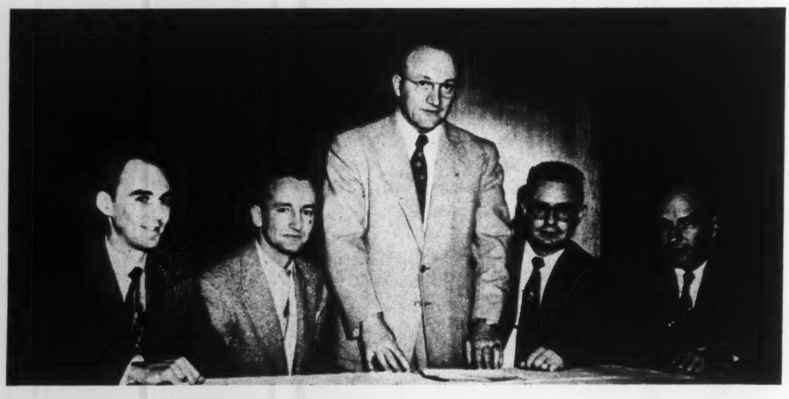
The **Akron Section's** slate of new officers—unanimously elected at a dinner meeting on January 20—are Harold H. Slater, president; William R. Wagoner, vice-president; and William H. Ruhlin, secretary-treasurer. In a talk entitled "Skimming the Milky Way," Ernest H. Cherrington, Jr., dean of the University of Akron's College of Liberal Arts, opened up new avenues of thought to the engineers.

New **Central Illinois Section** life members held the spotlight at the annual Ladies' Night celebration held at Urbana on January 18. Present to receive their certificates were Professors J. O. Draffin, W. H. Rayner, and C. C. Wiley, and E. F. Mail. The fifth life member, R. L. Bell, was honored in absentia. M. H. Alexander, associate professor of dairy science at the University of Illinois, was guest speaker with an illustrated talk on life in India, derived from a year and a half spent at the Allahabad Agricultural Institute.

Discussion of the planning and construction of a new building currently going up on the Ohio State University campus provided an interesting program for the **Central Ohio Section's** January dinner meeting. Howard D. Smith, university architect, was assisted in his presentation by two members of his staff—Lam Woo and Warren Jones.

Orchids to the **Cincinnati Section** for the success of its Second Sanitary Engineering Workshop—co-sponsored by the Civil Engineering School at the University of Cincinnati and held on the campus there on January 27. Industrial, municipal, and engineering officials came from four states to take part in the all-day informal discussion, which centered about an attempt to define ground rules for the development of industrial waste-control ordinances that will be generally acceptable to municipalities. It was pretty well settled that it is impossible to generalize on such ordinances or to establish a model which will serve equally well for all communities and situations, and that the practice of copying existing ordinances, which have been worked out for a certain community, and then attempting to apply them without proper study runs the risk of serious error or economic inequity. As guideposts for preparing control ordinances, it was also established that fewer mistakes will be made if municipal officials and industrial experts get together on the job; that industry can sometimes have its managerial thinking jarred to advantage; that the conference table approach "where honest men sit down to find honest answers," offers the best promise of success; and that small communities should retain competent consulting engineers to guide and represent them in developing sound contracts with industry in the matter of waste control.

There was an attendance of nearly a hundred for the **Colorado Section's** January meeting, which was highlighted by a talk by John MacLeod, president of the Associated General Contractors and head of the Macco Corporation, one of the nation's large contracting firms, with headquarters at Paramount, Calif. Mr. MacLeod's talk, entitled "Facing Our Mutual Problems," emphasized the fact that "civil engineers and general contractors are the same kind of people working toward the same objective . . . of building better projects more rapidly and economically." From his knowledge of AGC policies and practice, he asserted that the operations of the construction industry are very definitely in the public interest, but that the industry must "do ever better so that the public continues to receive greater value for its investment in construction."



Members of Jacksonville Subsection of Florida Section and their guests hear Bill Bryant (standing), city paving engineer, speak on municipal engineering at their January 25 meeting. Shown, in usual order, are E. R. Hendrickson, president of the Gainesville Subsection; Lewis Schield, president of the Florida Section; Mr. Bryant; John L. Clarke, president of the Jacksonville Subsection; and Byron Spangler, secretary-treasurer of the Florida Section.

J. Sterling Kinney (second from right) was elected president of the Mohawk-Hudson Section at its annual banquet on January 25. Photographed with him are (left to right) Earl Devendorf, new life member; retiring President George W. McAlpin; ASCE Director A. A. K. Booth; President Kinney, who is head of the Structural Engineering Department at Rensselaer Polytechnic Institute; and life member David A. McClung. Others receiving life membership certificates were Anthony J. Daino, Royal G. Finch, James P. McAvoy, William J. Manning, and Frederick G. Switzer.

President Glidden was guest of honor and speaker at the **Connecticut Section's** annual meeting, held in New Haven on February 1, with an interesting talk on conditions of practice, especially as regards the problem of unionization. Also honored were new life members Charles S. Farnham, Charles C. Kilby, Philip G. Laurson, and Charles P. Rumpf, who were present to receive their certificates, and Grey W. Curtiss, Theodore R. Sucher, Henry Willcox, Billings Wilson, and Harold G. Wynne, who received theirs in absentia. New Section officers, unanimously elected during the session, are Robert P. Vreeland, Jr., president; Arthur W. Sweeton, III, vice-president; and Earl R. Howard, secretary-treasurer.

At the Oregon Section's annual meeting retiring President Kenneth N. Phillips (left) hands to Gordon L. Burt, incoming president, the historic gavel presented by the Tacoma Section in 1930. Mrs. Burt looks on. The wood in the gavel came from a log buried in glacial drift and found some 200 ft underground while driving the Cushman power tunnel in western Washington. Its age is estimated at 25,000 years.

The effect of toll roads on both paralleling free roads and other nearby roads was discussed at the January 11 meeting of the **District of Columbia Section** by John T. Lynch, head of the Highway Planning Section of the Bureau of Public Roads. Mr. Lynch, who has played a prominent part in developing traffic survey techniques, reported several studies which show a definite pattern of traffic generation caused by the toll roads.

New officers for the **Duluth Section's Iron Range Subsection,** elected at a meeting on December 16, are Joseph Sikich, president; Richard Heil, vice-president; and John Eckman, secretary-treasurer. An illustrated talk on project planning—by Leo Zbanek, director of operations for the Taconite Contracting Corp., at Aurora, Minn.—provided an interesting technical program.

Formation of a committee to study Georgia's water resources before any legislation affecting them is passed was urged by the **Georgia Section** at a recent special meeting. Directing a resolution to the Georgia Water Use and Conservation Committee, the group suggested that the state form a committee empowered to make a complete study of every aspect of the situation and provided with adequate funds for the purpose. The community benefits resulting from properly managed forest properties and the effect of forests on water supply were outlined at a meeting of the **Central Savannah River Valley Subsection** on January 27 by John B. Hatcher, project forester for the U.S. Forest Service.

"Soil-Cement—the Adequate Low-Cost Pavement" was the theme of the technical program for the **Intermountain Section's** January meeting, with R. E. Spears, district engineer for the Portland Cement Association at Salt Lake City, the principal speaker. Honored as new life members were Lou Winsor, Mark Sanders, Carl Painter, and Lee Wendelboe.

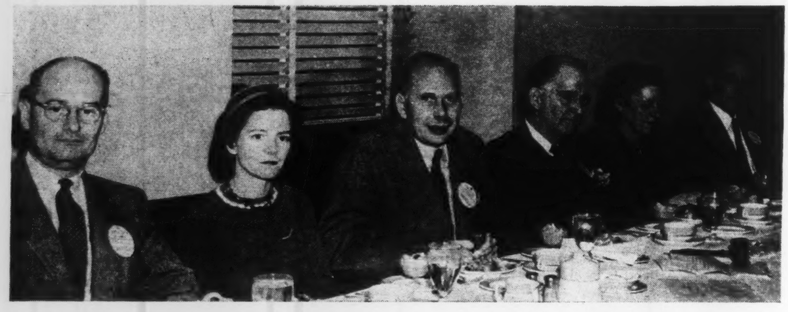
Arch N. Carter, manager of the Highway Division of the Associated General Contractors, was guest speaker at a recent joint meeting of the **Iowa Section** and the Iowa State College Student Chapter. Mr. Carter's comments on the construction industry drew a flattering attendance of students, despite competition with a basketball game scheduled for the same time.

A joint program of Cornell's Colleges of Agriculture and Engineering, which trains students for a number of engineering fields, was outlined at the **Ithaca Section's** January meeting by O. C. French, head of the agricultural engineering department. In December the Section met with other engineering societies in the area for a dinner meeting in Elmira. John A. Dessauer, of the Haloid Company, Rochester, gave an illustrated talk on the print-reproduction process by means of electronics.

Measures for cleaning up the Missouri River taken by the bordering states were discussed in the featured talk at the **Kansas City Section's** January meeting by Dwight F. Metzler, chief engineer and director of the Division of Sanitation of the Kansas State Board of Health. Mr. Metzler emphasized the industrial and municipal growth along the river from South Dakota to its mouth and the ever-increasing pollution load entailed and described the programs adopted by South Dakota, Iowa, Nebraska, Kansas, and Missouri to protect the water supply of their cities.

The **Kansas Section** starts the new year with publication of Vol. I, No. 1 of *The Civil Engineer*—another extremely creditable Section newsletter, which will keep

Dinner table group at the North Carolina Section's winter meeting, held in Raleigh in January shows (left to right) D. McGregor Williams receiving his certificate of life membership; P. D. Davis, who sponsored Mr. Williams; Section President R. E. Fadum; and Franklin T. Blythe, new life member. Also honored but not shown here were William H. Hall and Frank T. Miller. The state's highway needs were reviewed by W. H. Rogers, Jr., chief engineer of the North Carolina Highway and Public Works Commission, who said that $1,464,000,000 will be needed to construct and maintain adequate state roads in the next ten years. Industrial opportunities for civil engineers were outlined by Harold S. Sweet, group engineer in charge of the Lockheed Aircraft Corporation's structures, and "Urban Planning and the Civil Engineer" was discussed by Herbert W. Stevens, Raleigh director of planning. There was an attendance of about 80.



President Glidden visits the Northeastern Section, where he spoke on "Engineering Employment Conditions and Leadership" before an audience of 110. Appearing at the head, table, in usual order, are Prof. Ernest L. Spencer, secretary-treasurer of the Section; Mrs. Emory Ireland; Prof. John B. Wilbur, retiring Section president; President Glidden; Mrs. J. B. Wilbur; and Emory Ireland, newly elected president of the Section.

Seattle Section installs its new officers at regular January meeting. Shown, in usual order, are Richard J. Cole, secretary; Harlin H. Edwards, retiring Section president; Emil Jensen, president; and Hanford Thayer, vice-president. Treasurer Lawrence E. Hall was not present. Life membership certificates were presented to A. M. Sobieralski, E. F. Pugsley, Joseph F. Kunesh, and R. W. Lincoln. Honored in absentia was Theodore Grahlman.

members au courant with important local engineering news as well as with Section doings. T. L. Farmer is editor. New Section officers, unanimously elected on January 28, are William E. Gibson, president; Dwight F. Metzler, vice-president; and H. H. Hobrock, secretary-treasurer.

A color movie showing the construction of a tunnel to supply water to the Canadian hydroelectric generating station at Niagara Falls was enjoyed by members of the **Miami Section** attending the January 6 meeting. Engineers familiar with the project explained some of its features in greater detail.

The **Maine Section's** 1955 officers—elected at a meeting in Augusta on January 22—are Lucius C. Barrows, president; William H. Bradford and Grant L. Davis (New Hampshire), vice-presidents; Robert C. Haraden, secretary; and Ralph E. Barnett, treasurer. Representatives to the New England District Council are Neal D. McDowell and Grant L. Davis.

Europe and South America are beginning to find the cost of producing nuclear energy comparable with the costs of more common forms of power, which may force them into the lead in the race to exploit atomic uses, Tibor F. Nagey, manager of the Nuclear Division of the Glenn L. Martin Company, told members of the **Maryland Section** in a talk on nuclear energy developments given at the January meeting. With fuel and power requirements of the United States doubling every ten years for the past half century, atomic energy was seen as the best solution to the country's future power needs by the second speaker, A. F. Penniman, vice-president of the Baltimore Consolidated Gas, Electric Light and Power Company. Abel Wolman, professor of sanitary engineering at Johns Hopkins University, described research being carried out at the university on the disposal of nuclear waste, with emphasis on the fact that "no satisfactory solution has been found for the disposal of a rapidly mounting stockpile of high-level waste material."

The **Jackson Branch** of the **Mid-South Section** elected new officers in December—Karl A. Dupes, president; Horace B. Lester, vice-president; and James E. Foster, secretary-treasurer. O. B. Curtiss, secretary of the Mississippi State Board of Registration for Professional Engineers, was featured speaker with a talk on the present state registration law. For its January meeting the Branch sponsored a tour of the Concrete Research Division Testing Laboratory of the Waterways Experiment Substation at Jackson.

The pros and cons of competitive bidding for engineering services were aired at a recent meeting of the **Nashville Section** by a panel consisting of Arthur Crouch (chairman), Ross Bryan, D. A. Duplantier, and Clinton Parrent. The discussion questioned the efficacy of the ASCE Code of Ethics with regard to "today's world of municipal and public enterprises." R. N. Coolidge, Ivan Livingston, and R. C. Pierce were honored with life membership certificates. Another new life member, W. A. Vaught, was unable to be present.

Nebraska Section members awarded life membership certificates at the December meeting were Ake L. Alin, Carl M. Duff, and Richard O. Green.

"Steady progress" was made by the **New Mexico Section** in 1954, its Bulletin reports. The allocated membership has increased, it says, "and most heartening of all is a big jump in subscribing members." Recently elected officers for 1955 are Gordon E. Herkenhoff, president; Arthur A. Mosher and Ray J. Foss, vice-presidents; and Rufus H. Carter, Jr., secretary-treasurer.

ASCE affairs were discussed at the **Providence Section's** annual winter meeting by Frederick Paulson, Director for District 2. Mr. Paulson also presented

ASCE MEMBERSHIP AS OF FEBRUARY 9, 1955

Members	8,827
Associate Members	11,330
Junior Members	17,793
Affiliates	70
Honorary Members	44
Total	38,064
(February 9, 1954	37,124)

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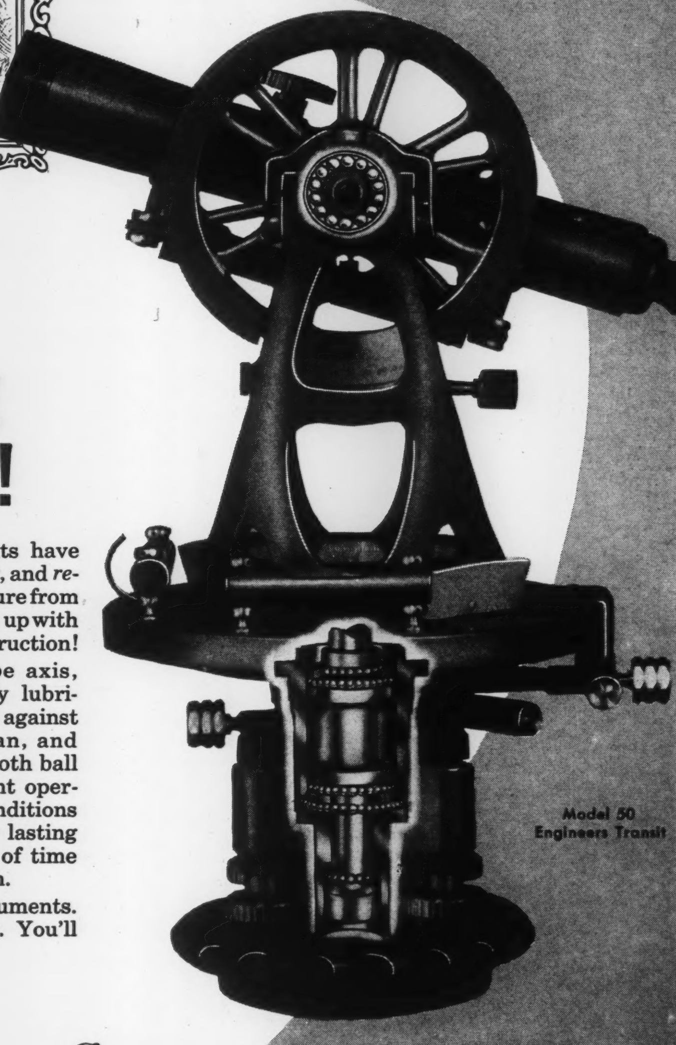

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a life membership certificate to George H. Henderson. Guest speaker Roger Chandler, traffic engineer for the city, stressed the difficulty of attempting to solve present-day traffic problems. There was a good attendance of students from Brown University (host to the meeting) and the University of Rhode Island.

J. Carl Jennings, assistant city engineer of Sacramento, heads the list of new **Sacramento Section** officers elected at the annual meeting on January 11 and installed during the annual dinner dance on the 15th. The rest of the slate consists of Ralph W. Hutchinson, first vice-president; Francis G. Christian, second vice-president; and Joseph I. Burns, secretary (reelected). As the result of a postcard survey, the Section will have more meetings— at least four dinner meetings (one each quarter), in addition to the traditional weekly luncheons and evening meetings, such as the Annual Installation and Ball and Ladies' Night. The **Marysville Subsection** celebrated its first birthday on January 14 with a dinner dance. Its new officers, installed during the evening, are Embree E. Reynolds, president; Bernhardt T. Berndtson, vice-president; Raymond G. Jacobs, secretary; and Anderson L. Morford, treasurer.

Factors affecting freeway design were outlined at the **San Diego Section's** January meeting by R. Arthur Hayler, assistant district engineer of design for the California Division of Highways. Mr. Hayler's talk covered the studies needed to determine freeway location and the reasons for the various designs chosen for modern state freeways. New life members honored with certificates were Edward S. Randolph and William G. Sloan.

In 1955 **San Francisco Section** affairs will be in the hands of Howard C. Wood, president; Robert Dewell and Blair I. Burnson, vice-presidents; Robert M. Kennedy, secretary; and Bernard A. Vallerga, treasurer. Daniel Shapiro will be **Junior Forum** president, and Kenneth Reynolds succeeds Gordon L. Laverty as editor of *The Civil Engineer*. The Section reports a strong technical program last year with ten of its twelve divisions holding meetings. Total attendance at these sessions was 969, only slightly less than the total for the six regular Section meetings.

At its annual meeting in Boise on Janary 21, the **Southern Idaho Section** elected the following new officers: Charles S. Bradley, president; John Graff, first vice-president; Henry C. Eagle, second vice-president; David Crandall, secretary; and F. C. Hart, treasurer. All are from Boise except Mr. Eagle, who lives in Idaho Falls. Featured speaker was Rex Jensen, who explained a plan authorized for irrigation of the Mountain Home project which involves construction of a dam and power plant at the Guffey site on Smoke River.

City planning for Spokane's future was the subject of a stimulating talk heard by **Spokane Section** members at their January 14 meeting. Harry Aumack, Spokane traffic engineer, was the speaker.

San Antonio's industrial possibilities were stressed by Gus F. White, manager of the industrial department of the local Chamber of Commerce, in the featured talk at a recent meeting of the **Texas Section's San Antonio Branch.** Mr. White said that opportunities for expansion exist, particularly, in the fields of food production, manufacture of clothing, and stone and glassware manufacturing.

C. H. Kurtz, Jr., has been elected 1955 president of the **Toledo Section.** The rest of the slate is P. M. Kiel, first vice-president; R. P. Scholz, second vice-president; and W. J. Gross, secretary-treasurer. Various uses of steel pipe in drainage structures and water lines were discussed in the featured talk by William C. Turnbull, sales engineer for Armco Drainage & Metal Products.

AMERICAN SOCIETY OF CIVIL ENGINEERS FOUNDED 1852

E. Lawrence Chandler (center), Assistant Secretary of the Society, was the principal speaker at the Wisconsin Section's January meeting. Shown with him (left to right) are some of the Section officers—T. B. Prawdzik, President Ralph Larson, Mr. Chandler, Richard Dess, and Herbert A. Goetsch. There was a large turnout to hear Mr. Chandler speak on collective bargaining.

Scheduled ASCE Conventions

ST. LOUIS CONVENTION
St. Louis, Mo.
Jefferson Hotel
June 13–17, 1955

NEW YORK CONVENTION
New York, N.Y.
Hotel Statler
October 24–28, 1955

DALLAS CONVENTION
Dallas, Tex.
Hotel Baker
February 6–10, 1956

Coming Events

Connecticut—New England Council Conference, March 26. Local Section Conference, March 24–25. Headquarters for both at the Statler Hotel, Hartford.

Dayton—Luncheon meeting at the Dayton Engineers Club on March 21 at 12:15 p.m.

Illinois—Noon luncheon meetings at the Chicago Engineers Club, 314 S. Federal Street, March 11 and 18.

Metropolitan—Dinner Meeting at the Hotel Statler, N.Y.C., March 16. Cocktails at 6:00 p.m.; dinner at 7:30 p.m. Tickets $5.00 per person.

Mid-South—Evening meetings of the Little Rock Branch at Granoff's Restaurant, Little Rock, on the third Wednesday of the Month.

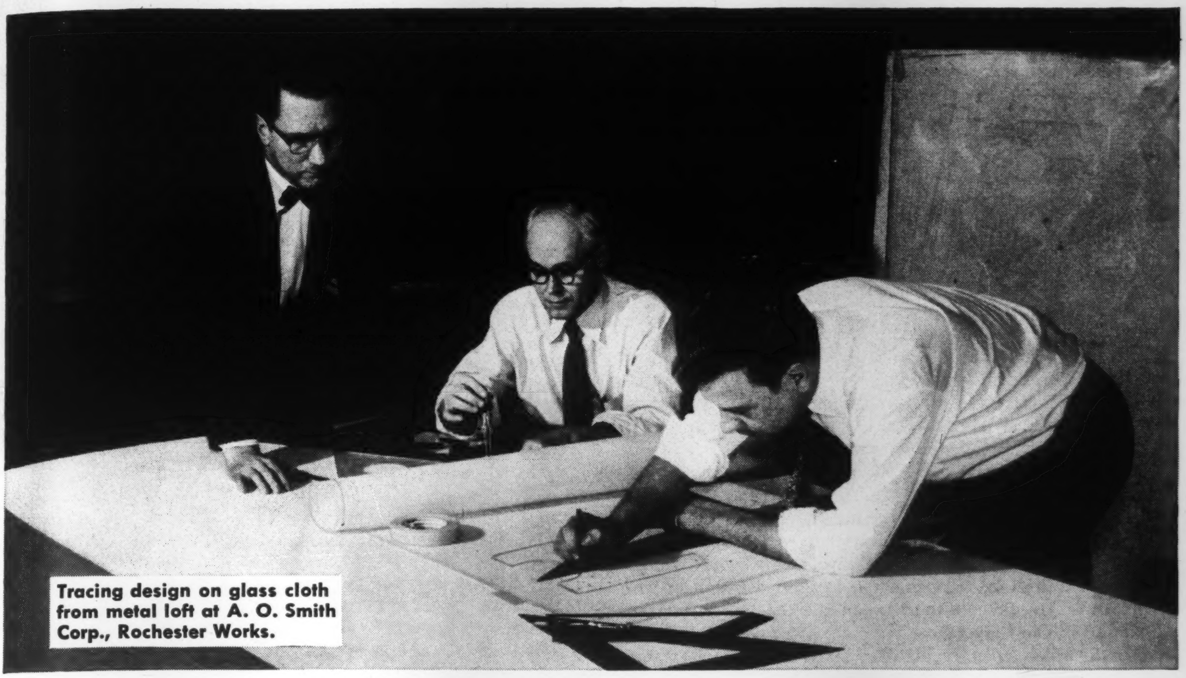
New Mexico—Spring Meeting, at A. & M. College, April 15 and 16. A visit to White Sands Proving Ground is planned for April 16.

Sacramento—Weekly luncheon meetings at the Elks Temple every Tuesday at 12 noon.

San Francisco—Wednesday luncheons at the Engineers Club. Tickets at the desk at $1.50 per person.

Spokane—Moscow-Pullman Spring Meeting, Moscow, March 26. Meeting, at the Washington Power Auditorium, April 8, at 7:30 p.m.

Syracuse—Meeting on "Public Transportation in Urban Areas" at the Museum of Fine Arts, March 22, at 8 p.m.



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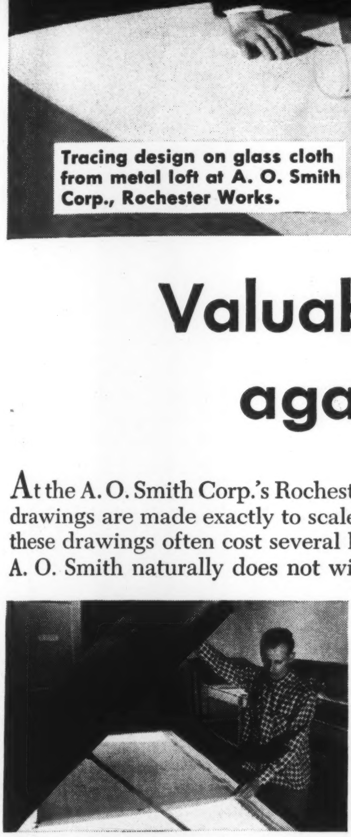

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FROM THE NATION'S CAPITAL

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Field Representative ASCE

Highway Legislation

The President's message in his road program has reached Congress. In it he recommends a $101 billion expenditure over a 10-year period, the federal share to be $31 billion. In his message the President said, "I am inclined to the view that it is sounder to finance this program by special bond issue, . . . " In referring to where the money would come from, the message stated, "Financing of interstate and federal aid systems should be based on the planned use of increasing revenues from present gas and diesel oil taxes, augmented in limited instances with tolls." He did not touch upon the reimbursement proposal of the Clay report for roads already built or to be built which meet required standards for the interstate system. In short, the President dwelt on the cost of our inadequate highway system in terms of the appalling toll of lives, the needs of national defense, and the expenses resulting from accidents and poor operating conditions. He suggested that Congress take advantage of the impartial findings of General Clay's Committee in developing a solution to the problem.

Senate bill, S. 1160, has been introduced by Senator Martin embodying the recommendations of the Clay report.

H.R. 234, "The Federal-Aid Highway Act" is something of a codification of various laws in the highway field.

Meanwhile Senator Gore, chairman of a Subcommittee on Roads, has submitted S. 1048. It calls for increasing federal aid from the $875 million approved in the last Congress to $1,600 million annually for 5 years. Of this, $500 million would be for the interstate system, to be divided among the states according to a formula which would call for a federal contribution of two-thirds of the cost plus an adjustment depending on the proportion of federal lands in a state to its total area. No bond issues would be involved under this proposal. Serious questions have been raised as to whether the key interstate system could be built in the 10-year period as urged, if the Gore bill were to become law. The Governor's Conference report follows the recommendations of the Clay report rather than the Gore proposal.

Water Pollution and Air Pollution

In his message on health the President recommended "Greater assistance to states for water pollution control (with indefinite extension of the Water Pollution Act, which expires June 30, 1956) and stepped-up federal research on air pollution."

Numerous bills have been introduced to implement the recommendation. S. 890 would extend and strengthen the present Water Pollution Control Act. S. 917 is designed to encourage the prevention of air and water pollution by allowing the cost of treatment works to be amortized at an accelerated rate for income tax purposes. H.R. 3680 would promote research relating to air pollution. The EJC Water Policy Committee has under study the various measures relating to water pollution, as well as H.R. 1824 which would establish a national water policy.

Several bills relating to stream pollution (H.R. 414, H.R. 1833) have been introduced, one to provide for research on air pollution (H.R. 2129) and several to assist in the construction of facilities to combat air pollution (H.R. 3551).

Miscellaneous Legislation

H.R. 860 provides for the establishment of a Public Facilities Construction Administration to provide construction programs for areas of unemployment.

H.R. 2179, a proposed "National Defense Science, Education Act," would establish a commission to provide scholarships in scientific subjects to increase the supply of science and technical manpower.

Federal Salaries

The question of obtaining and retaining engineering employees in the government is one in which the Society is profoundly interested. The following is excerpted from testimony submitted for the record of the hearings on pay bills for employees in the Classified Civil Service by the ASCE Field Representative.

"The engineering profession has been greatly concerned about the ability of both industry and government to obtain a sufficient number of engineers to maintain the technological superiority of the United States and to enable it to carry on the great scientific and engineering programs that the President has recommended. . . .

"In the past, increased responsibility demanded of those in the higher grades has not been accompanied by a corresponding increase in remuneration. Similarly younger engineers in the lower grades should be induced to seek such greater responsibilities of the higher grades through a proper schedule of salaries in these higher grades. . . .

"The following resolution was approved by the Board of Direction of the American Society of Civil Engineers in 1954:

> 'Federal pay scales for engineers should be maintained at levels comparable to those prevailing in corporate, industrial, and private practice. ASCE favors legislation authorizing compensation changes to include proportionately larger increases for engineers in the higher grades of the Classified Civil Service.'

"I request that this statement be incorporated in the record of the hearings in general support of the pay bills providing for increased compensation for employees in the Classified Civil Service."

Washington, D.C.
February 23, 1955

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NEWS BRIEFS . . .

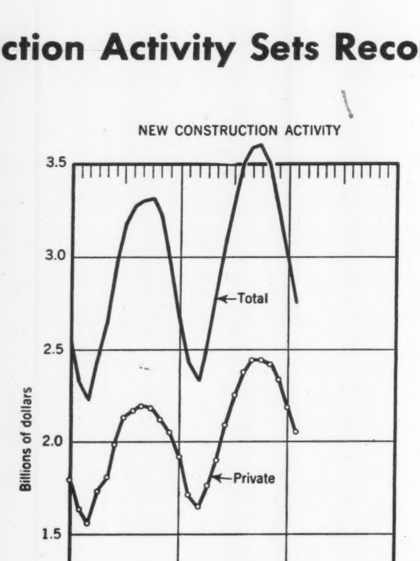
January Construction Activity Sets Record for the Month

The year 1955 opened with new construction activity at a higher level than in any previous January, according to preliminary estimates prepared jointly by the U. S. Departments of Commerce and Labor. The $2.8 billion outlay during the month represented a somewhat smaller decline than is usual from December to January, and was 13 percent above the previous January high of last year.

On a seasonally adjusted basis, the annual rate of construction expenditure during January 1955 exceeded the $40 billion mark for the first time, and compared with an annual rate of $38.2 billion indicated in the previous quarter and actual outlays of $37.2 billion in the year 1954.

Private construction, valued at $2 billion and up nearly 20 percent over January 1954, set a new record for the month. A continued expansion in new homebuilding has been the principal factor in raising private construction to a new mid-winter high. Private housing starts set a fourth-quarter record in 1954, and indications are that there was a greater number of homes under construction last month than in any previous January. The $1 billion of private homebuilding activity was the best January performance on record and one-third more than the year-ago total.

Although residential building accounted for most of the over-the-year increase in private activity, there were also big increases in religious, educational, and commercial building. Private outlays for each of these classes of nonresidential building were the largest ever recorded for the month of January.

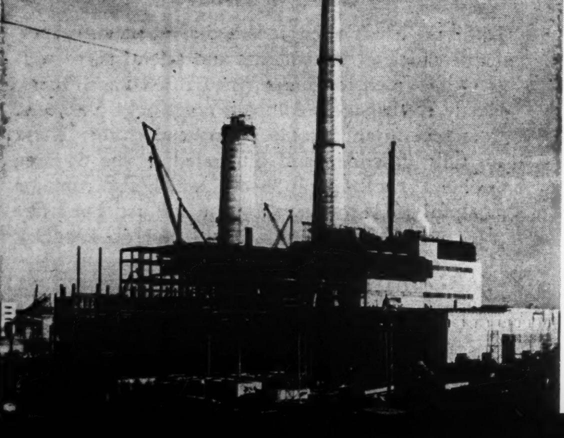


January construction expenditures, at $2.8 billion, are 13 percent above the previous January high reached in 1954, as indicated in Department of Commerce Curves.

The moderate increase in private industrial construction, which started last October, continued in January with a small rise to $175 million, although a decline is usual at that time of year. This figure was only slightly less than in the same month of a year ago. Utility construction was about the same as in January 1954, while building activity on farms declined somewhat.

Public construction activity in the opening month of 1955 was at the same level as in January 1954, $734 million, with reduced federal outlays offset by increased expenditures by state and local governments. The sharpest decrease from January 1954 was for federal work at industrial facilities, principally atomic plants. This decline, along with a reduced volume of public housing and conservation and development activity, was offset by increased military construction and the over-the-year expansion shown for state and local government work.

School building during the month showed a greater volume of activity than any other type of public construction, with the $175 million of work put in place setting a new January high, 17 percent above the previous record set in January 1954. Expenditures for new highway construction and sewer and water facilities also were greater than in any previous January.



Kyger Creek Plant Produces Power for AEC Project

First 200,000-kw turbo-generating unit of the Kyger Creek Plant has gone into operation at Cheshire, Ohio, to supply power for the Atomic Energy Commission's gigantic new uranium diffusion plant near Portsmouth. Both this and the Clifty Creek Plant (August 1954 issue), which has also gone into limited operation, are being built by the Ohio Valley Electric Corp., a group of private utilities. When the final unit of a projected series of eleven goes on the line early in 1956, the two plants will have a total generating capacity of 2,200,000 kw, the largest ever built by private industry. Indicative of the speedy construction schedule is the fact that the transition from drawing board to operation was made in slightly more than two years.

New Headquarters for The Asphalt Institute

After thirty-five years with headquarters in New York, the Asphalt Institute has moved its executive offices and laboratories to the campus of the University of Maryland at College Park, Md. The new location is expected to offer expanded research and testing facilities, and will have the additional advantage of proximity to the many government agencies in Washington.

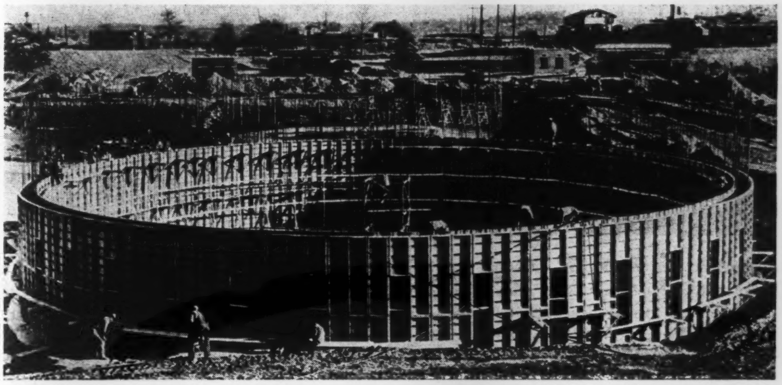
A. E. D. Meeting Pledges Support of Road Program

The men who manufacture and sell the nation's heavy construction machinery pledged their full support to the President's $101 billion highway program in a unanimous resolution passed at the Associated Equipment Distributors' 36th annual meeting in Chicago. The resolution commends President Eisenhower's "forthright and realistic approach to the critical problem" and urges vigorous prosecution of his ten-year road-building plan "by whatever means and financial methods the Congress may decide upon."

More than 2,500 machinery men representing 800 United States and Canadian firms attended the meeting, which was one of the largest in the association's history. The five-day program was designed to acquaint members with current trends and to arm them with up-to-date management information, as well as to attack industry-wide problems.

Ray J. Finn, president of the Bode-Finn Co., Cincinnati, was installed as 1955 president of the organization. Other new officers elected are S. F. Laskey, Fargo, N. Dak., executive vice-president; L. M. Doolen, Lansing, Mich., vice-president; H. D. Anderson, Bluefield, W. Va., vice-president; M. F. Macdonald, Quebec, Canada, vice-president; and F. J. Fitzpatrick, Hyde Park, Mass., treasurer.

Birmingham, Ala., Builds New Sewage Treatment Plant



Six circular digester tanks, each 100 ft in dia, with concrete walls 29 ft high, constitute a million-dollar sewage treatment project under construction for the city of Birmingham, Ala. Pour openings are being left at intervals in the first lift of forms, which is 16 ft high, so that the concrete drop can be kept within the prescribed limit of 4 ft. The openings are closed off by 2 x 4 panels as the concrete is brought up. Some 10,000 sq ft of Symons forms are required to form the first lift of each tank. The remaining 13 ft of wall height is completed in a single lift. Charles Snuggs, of Birmingham, is the engineer on the project, and Sullivan, Long & Haggerty the general contractor.

1954 Was Second Best Year for Homebuilding

With non-farm housing starts in 1954 totaling 1,215,500, the total for the year was 10 percent above the 1,103,800 units put under construction in 1953 and second only to the record 1950 figure of 1,396,000, according to a Bureau of Labor Statistics report. The December total of 91,000 included 89,600 privately owned units, which represented a seasonally adjusted annual rate of 1,483,000 starts—an unprecedented rate for December, and nearly equal to the all-time peak rate of 1,496,000 set in June 1950. The increase in 1954 was greatest in metropolitan areas, where total housing starts (public and private) rose over the year by 12 percent.

According to Secretary of Labor James Mitchell, the exceptional number of dwelling units started in the latter part of the year reflected substantial increases in the supply of funds for mortgage investment, as well as the liberalized loan provisions of the Housing Act of 1954.

With figures in for the first nine months of the year, the South accounted for the largest number (three-tenths) of all the new units begun. The North Central, Western, and Northeastern regions followed in that order. Allowing for variations in population density among the regions, the rate of homebuilding per capita in the West was well over twice that for the Northeast.

Aluminum Co. of America To Expand Davenport Works

Work is about to start on a major addition to the aluminum rolling equipment at the Davenport, Iowa, works of the Aluminum Company of America. The $5,000,000 facility will consist of a 100-in. cold mill for finish rolling wide aluminum coiled sheets, used extensively in the fast-growing field of aluminum-clad buildings, as well as in the aircraft and other transportation industries. It is expected that the mill will be in operation early in 1956.

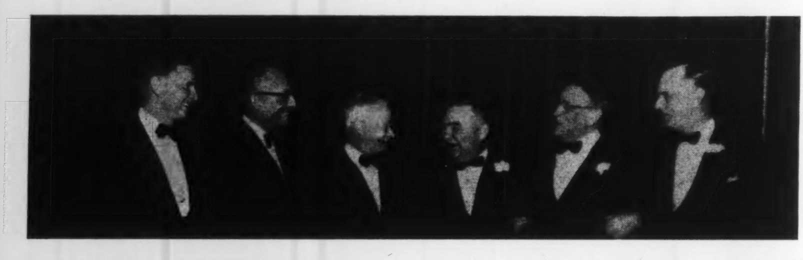
Brazil Dedicates Huge Hydroelectric Project

Brazil's most important postwar hydroelectric power development, the 180,000-kw Paulo Afonso Project, was dedicated by President Joao Cafe Filho on Jan. 15. Two of the project's three 60,000-kw generating units are now in operation at the station, which is located between the states of Alagoas and Sergipe, 155 miles from the Atlantic Coast. The third unit is being erected. When completed, the plant will bring modern low-cost power for the first time to some fifty cities and towns in the northeastern states. The entire 900,000-kw power potential of Paulo Afonso Falls in the San Francisco River, second longest in Brazil, is scheduled for development later.

The new generators were installed in a subterranean concrete-supported powerhouse that is 190 ft long and 49 ft high. Water for driving the turbines enters natural penstocks cut vertically in solid granite. It is then channeled by two diversion dams—one of them 33 ft high and two and a half miles long. Two of the world's longest transmission lines, 250 and 285 miles long, will carry power from the plant site to the port cities of Recife and Salvador.

Located more than 170 miles from the nearest railroad, the project was serviced during construction by a fleet of 75 large trucks. All electrical equipment was supplied by the Westinghouse Electric Corporation.

Two Contractors Honored at Moles' Annual Dinner



Assembled for the Moles' fifteenth annual award fete are (left to right, in usual order) President George F. Ferris; Carl B. Jansen, non-member award winner; Richard L. Hearn, chairman of the Hydroelectric Power Commission of Ontario and principal speaker; Thomas J. Walsh, member award winner; Admiral Ben Moreell, award winner in 1943, who made Mr. Walsh's presentation; and Edward G. Johnson, chairman of the Award Committee.

The highest honor in the heavy construction field was presented to two contractors—Carl B. Jansen, M. ASCE, of Pittsburgh, and Thomas J. Walsh, of Davenport, Iowa—at the fifteenth annual banquet of the Moles, New York society of heavy construction men, held at the Waldorf-Astoria on February 2. Messrs. Jansen and Walsh became the fifteenth pair of winners of Moles' awards, which are annually given to one member and one non-member for outstanding achievement and contributions to the art of heavy construction.

In welcoming the group of over 1,000 Moles and their guests, President George F. Ferris made some observations regarding the apparently "boundless optimism" of the current crop of Moles, saying that must be the explanation for the consistently low bids that characterize today's job-exploring situation. Several other comments of the sort were made during the evening, and there seemed to be general sentiment that contractors' estimates nowadays are quite chronically very much on the low side.

Rapidly expanding Canadian industry in Ontario, dependent almost entirely upon water power, "will have to look to other sources of energy within ten years," said Richard L. Hearn, M. ASCE, chairman of the Hydroelectric Power Commission of Ontario, in the principal address of the evening. He said that energy from the vast St. Lawrence power project will be utilized to capacity by 1962, only four years after the first generator will have gone on the line. In addition, he pointed out that the project will be the last major hydroelectric source available in all of Ontario. He did not suggest any alternative type of power source that might be utilized after 1962.

Dr. Hearn was made an honorary member of the Moles. Also, of course, Mr. Jansen, the new non-member award winner, joins the permanent role of Moles on the honor list.

Mr. Jansen has been connected with the Dravo Corporation since his graduation from Union College in 1922, and has been president of the company since 1946. In accepting his award, he pointed to the satisfactions to be gained in pursuing construction as a life work, and said that the industry is in many respects the greatest working example of the free-enterprise ideal. However, he expressed some concern lest the practice of joint venturing—undeniably necessary in many large operations—become too much of "a habit" in the industry.

Mr. Walsh, member recipient, has been board chairman of the Walsh Company since 1946, and was president of the company for thirty years before that, taking over upon the death of his father in 1916. One of the nation's largest contracting firms, the Walsh Company has driven more tunnels than any other company in the world.

Private Atomic Power Plant to Be Built Near New York

Construction of the country's first atomic electric power plant to be built by private industry is planned by the Consolidated Edison Company of New York. The plant, which will feed electric energy into the Edison system for New York and Westchester, will be built at Indian Point on the Hudson River, five miles south of Peekskill, N.Y. Its cost is put at from $30,000,000 to $40,000,000.

The reactor being considered is known as a converter (it is not one of the five types of reactors that the AEC has in its reactor demonstration program). The converter uses Uranium 238 to produce plutonium, which may be used to keep firing the atomic furnace. According to H.R. Searing, president of the company, the converter produces an "overall result which we hope will be reasonably competitive with conventional plants in the area." The relatively high cost of conventional fuels in the New York area was a motivating factor in the decision to study the economics of a reactor as a power producer, he emphasized.

The price the government charges for nuclear materials and the prices paid by the government for any material produced in atomic furnaces were not a factor in the company's decision, Mr. Searing said. Prices involved were relatively small against the overall cost, he noted. Under the law the government retains ownership of all nuclear material and charges a rental for use of it.

The country's first major power reactor, a joint venture of the Atomic Energy Commission and the Duquesne Light Company of Pittsburgh, in now under construction at Shippingsport, Pa. Of the pressurized water reactor type, the plant will have a capacity of 100,000 kw.

It is expected that it will be at least a year before construction of the Peekskill plant can start because of necessary design and fabrication work, and that a minimum of four years will be required before the plant could be ready.

Detroit to Have New Cement Plant

Plans for the erection of a new cement-manufacturing plant in the metropolitan Detroit area are announced by the Peerless Cement Corporation. With an annual capacity of 1,000,000 barrels, the plant will increase the company's present plant facilities by about 25 percent. The decision to build the new plant, which is scheduled to go into production late in 1956 or early in 1957, was based on the expectation that construction activity in Michigan, Ohio, and Indiana will be substantially greater in the next ten to fifteen years.

Dravo Receives Contract For Mississippi Bridge

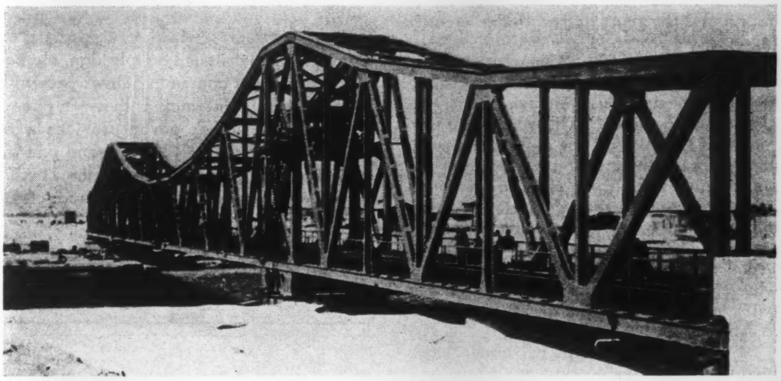
A contract to build four huge piers for the new $65,000,000 Mississippi River Bridge linking New Orleans and Algiers, La., has been awarded to the Contracting Division of the Dravo Corporation by the Mississippi River Bridge Authority. The low-bid contract of $6,691,590 includes construction of one pier as high as a 34-story building, which will be one of two supports for the 1,575-ft main span. Before sinking the steel caisson for this pier, a 150,000-sq ft mattress of willow branches will be placed on the river bottom to keep the current from washing away silt and mud during construction of the pier. Completion time for the pier project has been set at 670 calendar days.

Steel Capacity Up in 1955

The nation's steel industry started 1955 with an annual productive capacity of 125,828,310 net tons of ingots and steel for castings, according to the American Iron and Steel Institute on the basis of reports from the major steel-producing companies. This new total, the highest ever achieved, represents an increase of 1,497,900 tons over last year's output of 124,330,410 tons. The increase augments the industry's reserve margin for defense needs. The reserve is large, as indicated by comparing production and capacity in 1954, when operations averaged about 71 percent of capacity.

As a result of the steel-companies' large-scale expansion and improvement programs, there has been an increase of nearly 34,000,000 tons, or about 37 percent, in the annual capacity of the industry. Blast-furnace capacity went up 1,969,710 tons during the past year, and is now rated at 83,971,100 tons annually, while coke capacity is rated at 72,684,750 tons a year. With the improved quality of raw materials, this permits operating over 95 percent of the blast-furnace capacity without the use of coke from sources outside the iron and steel industry, the American Iron and Steel Institute notes.

New Railway and Vehicular Bridge to Cross Suez Canal



General view of the new double-swing Suez Canal Bridge as seen from the Asian shore is shown at the left. The single-track structure is decked to permit its use as both a railroad and vehicular crossing. Cast-iron counterweight boxes are provided at the end panel of each short arm.

Nearing completion over the Suez Canal below the El-Ferdan station of the railroad connecting Ismailia and Port Said, Egypt, is a new double-swing railroad and vehicular steel bridge, which will provide the only crossing between Africa and Asia. The floor of this single-track structure is decked for passage of vehicles when no trains are scheduled to cross. Electrically operated, it replaces a hand-operated swing bridge of similar design that was found inadequate to handle the increasing civilian and military traffic between Egypt and its Sina Desert as well as between Egypt and the Arab countries in Asia.

In addition to increased traffic capacity, the new bridge is designed to provide a wider navigable channel (315 ft between fenders) than the old structure, permitting the largest steamers to pass through the canal. It consists of two identical swing spans 344 ft 6 in. long, with main girder trusses of unequal arms. A cast-iron counterweight box is provided at the end panel of each short arm.

The swing itself consists of a double cantilever steel truss structure of the through type with unequal arms—seven panels on one side and six on the other in addition to a cross-braced central panel over the pivot pier. The turntables are of the rim-bearing type with turning rollers on center pivot piers, end lift wedges on abutments and two locking pins between the bottom chords of the swing spans at the center. The height of the superstructure is 24 ft $7^1/_4$ in. at the ends and 49 ft $2^1/_2$ in. over the pivot piers.

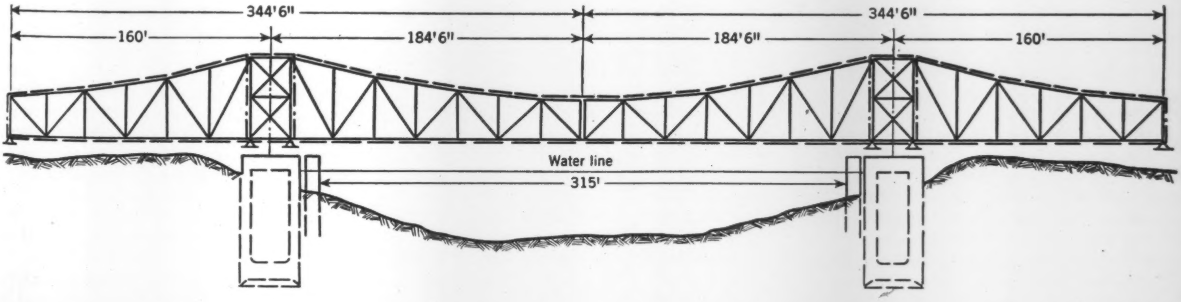
The rack and pinion system turning each swing span is electrically driven by two separate 10-hp 440-v d.c. motors, running at a maximum of 750 rpm. In case of necessity, one of the motors can be cut out and the entire load shifted to the other. Complete opening of the swing span requires only four minutes.

When the new structure is completed, it will be one of the longest bridges of its kind in the world. [The clear channel of the double-swing Yorktown Bridge is 450 ft.] With a total length of 693 ft, it will be almost 200 ft longer than the structure it replaces. Vertical clearance will be only slightly higher—14 ft 7 in. at high water instead of 14 ft.

The bridge was designed in the bridge engineering office of the Way and Works Department of the Egyptian State Railways under the supervision of the consulting firm, Soad Soudy & Lotffy Hashim. The resident engineer was Fahmy Tolba, of the Way & Works Department, and the builder Baume & Marpent, of Hainf-St. Pierre, Belgium.

Information for this item was supplied by Nashaat Morsy, architect-consultant to the Courts, Cairo, Egypt.

The old cross-canal swing bridge at El Ferdan, which was to have been dismantled upon completion of the new structure, was rammed by a freighter late in December and fell blocking the canal for four days and causing a 100-ship traffic jam.



N. Y. State Gives Classes for Its Highway Engineers

Since 1950 the New York State Department of Public Works has been conducting continuous classes for its engineer personnel. The first classes were for persons preparing for professional engineering examinations. The response was so enthusiastic that these classes have been given continuously ever since.

A year later classes were started for engineers in the lower grades, and these have been given whenever and wherever requested by the Department's engineers. Both courses have been conducted in conjunction with local state adult education programs, and capable instructors have been found from among the Department's engineers.

More recently the Department has sponsored a series of classes for supervisors, instruction being given in each of the ten districts of the state. The purpose of the courses is twofold. They build up department morale by giving its engineers an opportunity to improve their professional knowledge, and to get recognition of their improved knowledge by passing examination for promotion to higher grades. From the Department's viewpoint, the educational program enables its more capable engineers to take on more difficult assignments.

At the other end of the personnel scale, recruiting for engineering positions has been limited to persons with engineering training and experience. For the past year the Department has been working with Rensselaer Polytechnic Institute and the Hudson Valley Technical Institute to develop a two-year highway-training program for exceptional high school students with engineering aptitudes. It is expected that summer work will be available to those whose college marks entitle them to it.

Movie on Building May Be Borrowed

The marvels of modern construction are unfolded in a color, sound film called "The Builders," which is available for booking without cost to the user except transportation charges. Intended for general as well as engineering audiences, the footage describes many new building developments and points up the vital role played by welded wire fabric in reinforcing present-day structures. It shows job applications in thirteen states. The running time is half an hour.

The sponsor of the film is the Wire Reinforcement Institute, Inc., Washington, and the producer Industrial Motion Pictures, Inc., Cleveland. Distribution is handled by Modern Talking Picture Service, Inc., 45 Rockefeller Plaza, New York 20, N.Y.

Moving Rubber Sidewalk Installed in Houston, Tex.

Moving rubber sidewalk, featuring the widest (82-in.) conveyor belt ever used commercially to transport humans, begins operation at the Houston, Tex., Coliseum. First moving sidewalk to be installed on a bridge, the belt spans Buffalo Bayou at a height of 50 ft, rising 12 ft in its 114-ft course to deliver passengers to the exposition hall. It measures 230 ft in length and is $^{7}/_{8}$ in. thick, with seven plies of fabric for interior reinforcement. A specially compounded rubber cover provides a scuff-resistant, easy-to-clean surface. The belt travels at a speed of 132 fpm, and can handle 15,000 people an hour. Design and installation was a joint project of the Link-Belt Company, Houston and Chicago; the B. F. Goodrich Company's Industrial Products Division, Akron; and the Otis Elevator Company, New York City.

Accidents Do Not Just Happen

An interesting and valuable report has been published by the Pennsylvania Turnpike Joint Safety Research Group, analyzing all accidents on the Pennsylvania Turnpike during 1952-1953.

The current much-publicized Eisenhower Road Program is predicated in a large measure on the need to reduce the appalling number (38,000) of highway fatalities annually. This report substantiates the theory of better roads—fewer deaths. But of even greater significance is the analysis of what causes accidents under optimum driving conditions.

Standing out is the fact that 86.5 percent of all accidents were caused by driver error and only 13.5 percent were caused by vehicle failure. Predominant among the driver errors was "Failure to Cope with Road Conditions," which accounted for 42 percent of all turnpike accidents. The next largest category was inattention, which was the cause of 16.9 percent of all accidents during the study period. Intoxication was the cause of only 1.2 percent of the accidents.

The report states that speed itself is not a cause of accident, but rather overestimation of one's own abilities at given speeds. The greatest number of accidents on the highway occurred between 41 and 50 mph, while the average speed on the turnpike was between 53 and 63 mph. The report concluded that drivers tend to drive at speeds which are most comfortable to them. It was also noted from radar checks that although the average speed of vehicles dropped 10 mph during snow and sleet, there was no perceptible change in the average speed in rainy weather indicating a lack of awareness of the increased hazard of wet pavement.

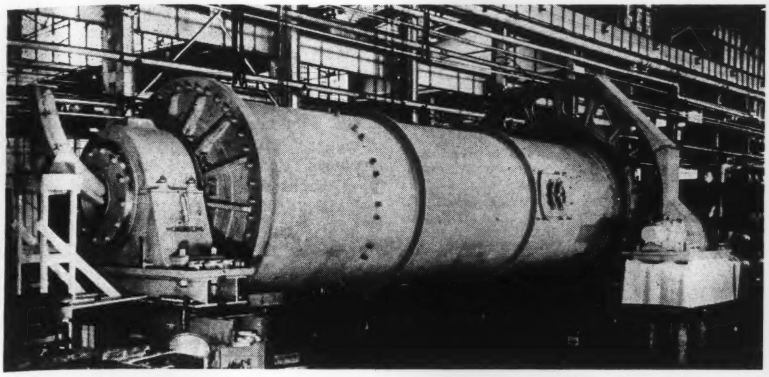
It was further noted that the accident rate on curved sections of turnpike was the same as on straight sections, 1.5 accidents per million vehicle miles. Likewise, the accident rate at night (including dawn and dusk) did not exceed the 1.5 per million vehicle miles of daylight driving. The studies also showed the majority of accidents occurred in good weather.

In summarizing, the report reemphasized the fact that accidents are basically the result of human error. Vehicular failures are a relatively small percentage of the total (and many of these probably result from driver negligence in checking his vehicle). Human error is not restricted to adverse environmental conditions. However, the possibility of human error is compounded by severe environmental conditions and as greater demands are put on driver ability, human error increases disproportionately.

Drivers under all conditions tend to underestimate the requirements of the driving task or else to overestimate their ability.

The human errors which cause accidents

Huge Mill Readied for the Cement Industry



Ready for shipment from the Milwaukee works of the Nordberg Manufacturing Co. is one of the largest grinding mills made for the Portland cement industry. The unit is one of five similar mills for grinding raw materials and clinker to finish cement, purchased by a major cement producer to expand its operations. The unit shown, which is intended for wet grinding of raw materials, measures $9^1/_2$ ft inside diameter by 34 ft inside length. It will be driven by a 1,500-hp, 189-rpm synchronous motor, direct coupled to the mill countershaft. Three special railway cars were required to transport the 400,000-lb unit to its destination.

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are not flagrant in all cases. A slight error can cause a large accident.

What's the answer? Education, says the report. "Accidents do not just happen—they are caused. They are primarily the result of driver error in failing to adequately modify his behavior to cope with the driving environment. Accidents are preventable. Driver education and training appear to be at the present time, the most promising key to accident reduction."

Organizations cooperating in the safety study are the Union Switch & Signal Division of Westinghouse Air Brake Company, the American Institute for Research, J. E. Greiner Company, and the Pennsylvania Turnpike Commission.

Newport Steel Opens Cold Reduction Mill

Formal opening of the Newport Steel Corporation's new reversing cold reduction mill at Newport, Ky., took place on January 26. A major project in the company's $9,000,000 expansion program, the new mill is equipped to reduce hot rolled pickled steel in coil to desired gauge widths up to 48 in. for shearing and further processing into cold rolled sheets. It was erected by the Industrial and Building Construction Division of Merritt-Chapman & Scott.

F. H. McGraw Co. to Rebuild North Church Steeple

Selection of F. H. McGraw & Co. to rebuild the famed North Church Steeple in Boston, one of last summer's hurricane casualties, is announced by the Lantern League of the Old North Church. Work on the steeple will get under way in the spring as soon as weather permits, and about five months will be required to complete the job. Considerable historical research has been done to assure that the rebuilt structure will be an exact duplicate of the spire from which the lantern alarm of 1775 was given.

The McGraw Company is undertaking the monumental job as a public service without fee, and several building materials manufacturers are donating materials.

Lehigh Portland Cement Co. Plans $15,000,000 Expansion

A $15,000,000 expansion project will be undertaken at the Union Bridge, Md., plant of the Lehigh Portland Cement Company. The seventh major project in the company's postwar expansion program, the installation will increase the annual output of the Union Bridge plant to 3,000,000 barrels of cement. It will be completed late in 1956.

NUCLEAR NOTES

X—Measurement of Radioactivity (Part 2)

This installment of "Nuclear Notes" was prepared at the request of the Sanitary Engineering Division's Committee on Sanitary Engineering Aspects of Nuclear Energy by Morton I. Goldman, J.M. ASCE, Senior Assistant Sanitary Engineer, Robert A. Taft Sanitary Engineering Center, USPHS, assigned to the Oak Ridge National Laboratory, Oak Ridge, Tenn. Conrad P. Straub, of the Oak Ridge National Laboratory, heads the committee, which also includes S. T. Barker, A. E. Gorman, Prof. Warren J. Kaufman, and James G. Terrill, Jr. Next month's article will describe techniques of measurement using the instruments described in this article.

Four types of radiation-detection devices were described in the March issue. They were: (1) Gas-ionization instruments, which are by far the most widely used and which may operate in either of three voltage regions for particular desirable characteristics—ionization chamber, proportional, or Geiger-Mueller; (2) photographic emulsions, used primarily in measurement techniques for personnel monitoring and radiography; (3) scintillation phosphors which respond to radiation by emission of light, and are most popular for their excellent gamma sensitivity; and (4) chemical dosimeters, which are insensitive to small quantities of radiation, and find their greatest application in measuring doses from intense sources or in civil defense monitoring.

Of the sensitive media discussed, two require additional electronic circuitry to indicate the quantity or intensity of radiation to which the instrument has been exposed. The photographic emulsion and the chemical dosimeter can be read directly by eye (although the films usually require elaborate apparatus for controlled development and a densitometer is usually employed to determine accurately film densities); gas ionization instruments and scintillation counters, however, require some indicator of the ionizing effects.

Electrons collecting on an anode produce an electrical charge, and if allowed to move through the conductor, produce an electrical current. The measurement of this charge or current is the function of the detection portion of the instrument. The total charge accumulated on an ionization chamber anode is a function of the total radiation exposure and can be indicated by the movement of a quartz fiber in an electroscope or by a similar instrument. Dose-rate measurements can be made either by noting the rate of accumulation of charge on an electroscope, or by passing the collected electrons through an external metering circuit and noting the current indication. Since the ionization chamber instruments collect only the primary ions formed, the amount of ionization current is extremely small and must be amplified by some technique before it can be measured by commercially available milli- or micro-ammeters.

Proportional counters, Geiger-Mueller counters, and scintillation counters produce pulses of current which are more difficult to relate to an average dose rate. These pulses of current can be integrated electronically to produce a flow meter current proportional to the average pulse rate or the average energy for pulse. They may be registered individually by an instrument known as a counter, or scaler, which is nothing more than an electronic adding machine with an attached timer capable of indicating the total number of pulses formed in the detector over a given time period.

Functionally, these radiation detection instruments can be classified according to use.

1. Survey instruments are battery-powered, portable, and may measure dose or dose rate. Usually ionization chambers or G-M counters (although proportional and scintillation counters may also be found as survey instruments) are used to measure the absorbed dose or dose rate of gamma radiation or to detect the presence of beta contamination. Proportional counters and ionization chambers are used to survey for alpha contamination.

2. Personnel monitoring instruments are small, light devices which record the total surface dose absorbed by the wearer. These are usually films, worn in a badge on the clothing, or pocket ionization chambers which indicate total charge collection that is measured either on a built-in electroscope, or on a separate electroscope instrument. Film badges are generally worn for a period of a week before development, while pocket ionization chambers are commonly read daily. The pocket ionization chambers are primarily sensitive to gamma radiation and the films are sensitive both to beta and gamma radiation. There are special films and chambers which will indicate the dose received from neutrons.

3. Laboratory instruments are non-portable and are usually of the pulse-counter type. They indicate accurately the pulse rate produced in a detector which may be either a gas ionization device or a scintillation probe. This rate is indicated on a scaler (counter) and attached timer, or on a highly accurate integrating rate meter. The laboratory instruments also incorporate sample mounting devices which permit accurate and reproducible sample placement with respect to the detecting element. The sensitive medium used depends upon the radiation to be measured. Proportional counters are most widely used for the measurement of alpha radiations, G-M counters for beta particle measurement, and scintillation counters for gamma detection although scintillation counters are coming into use for measurement of alpha and beta radiation.

This article has presented the basis of operation of radiation detection instruments, and a description of some of the functional groupings of particular instrument types.

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N*G*Neare's COLUMN

R. ROBINSON ROWE, M. ASCE

"Where's the Professor?" asked Cal Klater.

"I haven't seen him since the San Diego Convention," replied Stoop Nagle, "but he asked me to give you a harder problem if Joe Kerr solved the last one."

"That's all I want to know. Joe's been bragging too much that he's going to work every one this year and I . . ."

"And you've been doing all the bragging for 15 years and can't stand a little competition," yelled Joe. "Well, let's see you laugh off my answer to the first one. Here's a sketch of the 8 paths in the Quazy Quadrille (Fig. 1). Art started from *A*, went half way to *B*, faced left, and went the same distance *outward*. Belle started from *B*, met Art half way, faced left, and went the same distance *inward*. Similarly for the others. Guest Professor Nagle asked how far Ben was from Dan: well, it's $\overline{AB} + \overline{BC}$, the same as from Art to Carl, which he gave as 39 ft. Then he asked how far Ann was from Claire, and it's $\overline{AB} - \overline{BC}$, the same as from Belle to Dot, which he gave as 15 ft. So $\overline{AB} = 27$, $\overline{BC} = 12$, and the ballroom is slightly bigger, with doorways at convenient places."

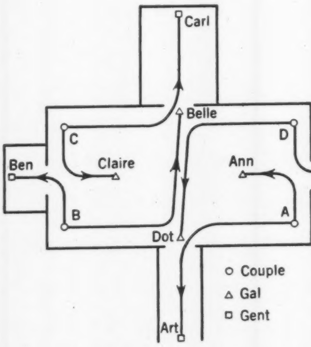


Fig. 1. Joe imagined a 12 × 27-ft ballroom and waltzed 3 boys into alcoves and Art down the hall.

"Right by a fluke," complained Cal Klater, "but you're all wrong on the dimensions and shape of ABCD. $\overline{AC}$ was given as 27 ft and you made it nearer 29. The general solution is any quadrilateral with diagonals measuring 27 and $\sqrt{1017}$ and diverging by arccot 0.875. If the diagonals bisect each other, the figure is a parallelogram with sides of $\sqrt{720}$ and $\sqrt{153}$, so if you want a solution in integers, spot the corners at (3,0), (0,12), (24,24) and (27,12)."

"Probably I did give Joe a break," admitted the Guest Professor, "but he still has 11 labors ahead of him, and I'm ordered to make the next one a bit more herculean. First, tho, let me point out that the 'quazy quadrille' was just a romantic way of describing squares diagonally on each side of a quadrilateral (Fig. 2). What seems evident with Joe's rectangle and Cal's parallelogram is true for any quadrilateral; the outer and inner vertices of the squares are invariently related $\overline{ac} = \overline{bd}$ and $\overline{a'c'} = \overline{b'd'}$. The invariance can be used to prove some interesting relations for a triangle by taking each vertex in turn as the double vertex of a degenerate quadrilateral.

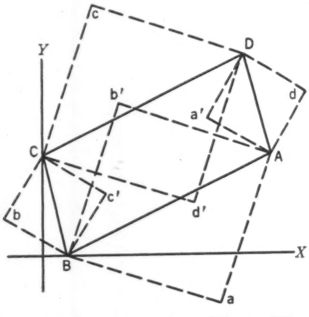


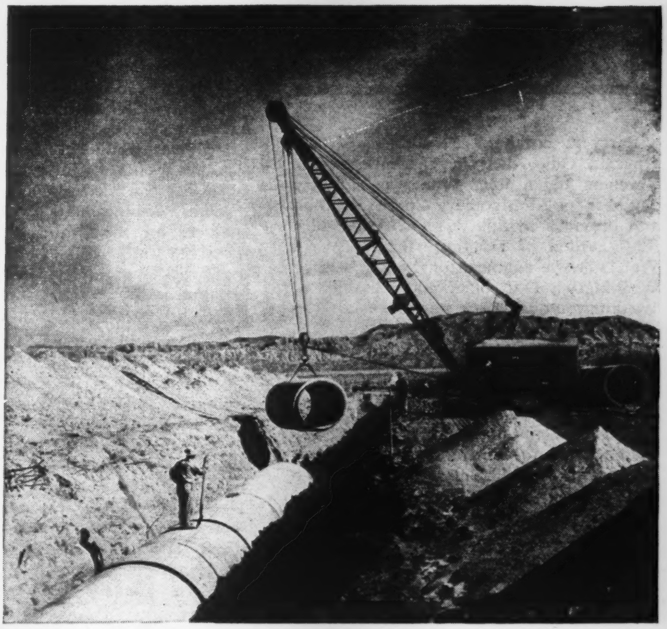
Fig. 2. Cal agreed that $\overline{ac} = \overline{bd}$ and $\overline{a'c'} = \overline{b'd'}$, but proved *ABCD* is not a rectangle.

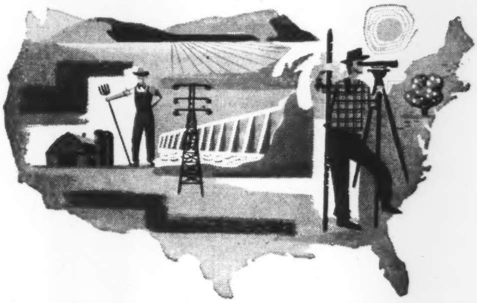
"Now for that slightly more herculean labor. Whether you're a buckrogerian or an aerosaucerian, imagine 4 space ships converging on the asteroid Marilyn. Just as each ship observes the other 3 on the horizon, one's sonarman reports distances of 15, 17 and 24 sonameters to the other ships and the radioman relays a message that two others are 8 sonameters apart. What is the equatorial diameter of Marilyn?"

[*Cal Klater was Thatchrite* (*Guy C. Thatcher*) *and the Guest Professor was John L. Nagle.*]

U. S. BUREAU OF RECLAMATION SPECIFIES

Concrete Pressure Pipe





When the U.S. Bureau of Reclamation builds a pipeline, it must last a long, long time.

This is why the Bureau has specified concrete pressure pipe in many projects under its jurisdiction throughout the Western States. In the State of California alone, approximately 3,000,000 feet of concrete pressure pipe have been used in diameters ranging from 12″ through 84″, and for heads up to 650 feet. These jobs include the Coachella Valley Project, the Cachuma Project near Santa Barbara, both barrels of the San Diego Aqueduct, and the Central Valley Project.

Large pipe distribution systems, often calling for heads of 200 feet and over, are jobs for concrete pressure pipe. So, when your city is planning a water transmission system with either low or high heads be sure to get the facts on concrete pressure pipe.

Member companies manufacture
concrete pressure pipe
in accordance with
nationally recognized specifications

Concrete
PRESSURE
Pipe

WATER FOR GENERATIONS TO COME

AMERICAN CONCRETE PRESSURE PIPE ASSOCIATION

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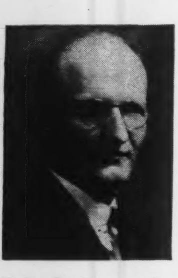
Chicago 1, Illinois

DECEASED

Perry E. Borchers (M. '30), age 73, of Dayton, Ohio, died in December. Mr. Borchers for a long time was sanitary engineer for Montgomery County in Ohio and previous to this was associated with K. B. Allen of Dayton. Before World War II he was engineer for the PWA in the Washington, D.C. office and remained in Washington during the war to work in the office of the Chief of Engineers, U.S. Army. Mr. Borchers was a graduate of Ohio State University, class of 1907.

Francis Lee Castleman, Jr. (M. '42), age 52, dean of the University of Connecticut school of civil engineering and well known educator and technical writer, died on December 30. After receiving a C.E. degree from Lehigh University in 1926, Mr. Castleman continued his studies at the University of Pennsylvania where he received his doctorate in 1935. During this period he was designer of bridges and buildings for the American Bridge Company. In 1935 he joined the faculty of Vanderbilt University as professor of structural engineering. Mr. Castleman became professor and head of the civil engineering department of the University of Connecticut in 1942 and was made dean in 1946.


F. L. Castleman, Jr.

John C. DeBolt (A.M. '50), age 51, chief of the Inspection Branch of the Corps of Engineers at St. Louis, died on November 28. Mr. DeBolt had been in the U.S. Engineer Office at St. Louis for thirty years, working on river regulation, channel diversion and locks and dams on the Mississippi. In 1944 he became engineer in charge of preparing river and harbor reports for waterways and harbors for seven lakes in the area. Most recently he was assistant chief of operations in the construction division and head of the river regulating works maintenance section.

Isidore Delson (M. '40), age 78, consulting engineer of Staten Island, N.Y., died on December 20. A civil engineering graduate of Columbia University in 1899, Mr. Delson was employed by the New York City Department of Bridges from 1905 to 1924 becoming assistant engineer of bridge design and construction in 1908. Joining the Department of Plant and Structures as engineer in 1924, he later was promoted to chief of the design division. In 1939 he held the post of assistant to the Deputy Commissioner for the Bureau of Bridges, and later started a private consulting practice.

Carl Laurence Gerhardt (M. '44), age 63, chief electrical engineer for the Tulsa (Okla.) District, Corps of Engineers, died in Tulsa on December 20. Born in Denmark, Mr. Gerhardt was educated there and also attended Northwestern University and the California Institute of Technology. Before joining the Corps in 1942, he was principal engineer for the PWA in Washington, D.C., and supervising engineer for the Grand River Dam Authority at Vinita, Okla. Mr. Gerhardt had been with various private companies in the capacity of electrical engineer.

C. Joseph Gooch (A.M. '18), age 66, consulting engineer of Brookline, Mass., died on December 19. A graduate of the University of Maine, class of 1910, Mr. Gooch served with the U. S. Reclamation Service in Montana from 1911 to 1918. After World War I he joined the New England Power Service Co. at Worcester, Mass., where he was engineer. Since then he has served the New England Electric System in various capacities, most recently as superintendent of line construction.

Henry L. Hagerman (M. '30), age 69, of Venice, Fla., died recently. Mr. Hagerman was long employed by the J. E. Sirrine, Mill Engineer and Architect, which he joined in 1906. From 1906 until 1919 he did mill construction work for the firm in the South and then settled in Greenville, S. C.

Adin Loring Hopkins (A.M. '53), age 61, division engineer for the Maine Highway Commission and a native of Camden, Maine, died on December 26. Mr. Hopkins started working for the Maine Highway Commission in 1934 as a junior engineer and became district supervisor of maintenance and state aid construction in 1937. In 1951 he was made division engineer for Waldo, Knox and Sagadahoc counties. Before joining the Commission, Mr. Hopkins had a private practice in Camden.

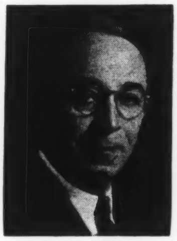
Wallace C. Lyon (A.M. '01), age 91, who was with the Treasury Department from 1893 until his retirement in 1933, died at his home at Hyattsville, Md., on December 28. Prior to his work for the government, Mr. Lyon was employed by various architects in Louisville, Ky., where he designed the new Bardstown court house. Mr. Lyon was designer of many Federal vaults and mints while he was with the Treasury Department.

Robert James Middleton (A.M. '07), age 73, retired chief engineer of the Chicago, Milwaukee, St. Paul & Pacific Railway, died on December 21. Mr. Middleton graduated from the University of Arkansas in 1903 and, after three years with various firms, joined the western railroad's office in Kansas City. Mr. Middleton also worked in the Seattle and Chicago offices where he was chief engineer. He had been living in Seattle, Wash.

Theodore Frelinghuysen Miller, Jr. (J. M. '52), of Escondido, Calif., died recently while in service as a first lieutenant in the U. S. Army Air Force. Mr. Miller entered the Army following his graduation from the University of Arizona in 1952.

Frank L. Raschig (M. '13), age 76, retired director of the Ohio Department of Public Works, died in Cincinnati on December 27. Mr. Raschig was director of the department from 1940 to 1947 and then consultant to it until his retirement in 1948. Earlier he had been principal assistant engineer in the Structural Division of the City of Cincinnati; chief engineer of the Cincinnati Rapid Transit Commission; and engineer for the Asphalt Sales Department of the Standard Oil Company of Ohio. Mr. Raschig was a graduate of the University of Cincinnati.

Albert Ralph Ellis (M. '33), age 73, since 1951 chairman of the board of the Pittsburgh Testing Laboratory, died on December 24. After graduating from Cornell University in 1905, Mr. Ellis started work for the Pittsburgh Testing Laboratory as an inspector. In 1918 he was promoted to assistant to the chief executive, becoming general manager three years later, vice-president in 1928, and president and director in 1936.


A. R. Ellis

Alfred K. Stillman (M. '49), age 54, partner in the firm, DeWitt C. Griffin & A.K. Stillman in Seattle, Wash., died in November. Mr. Stillman was sales engineer for Emulsified Asphalts for five years and with the Washington State Highway Department for six years. During the war he was associate engineer at Fort Lewis, Wash., and later started his own practice. More recently he had been a partner in the Seattle firm.

Charled E. Stricklin (M. '43), age 70, since 1930 state engineer of Oregon and widely known as an authority on problems of reclamation, irrigation and water law, died in Merced, Calif., on November 8. Mr. Stricklin received his C. E. degree from Oregon State College in 1911 and a degree in law from Willamette University in 1918. He had been in the Oregon State Engineer's office since 1919, when he became assistant state engineer in charge of irrigation. In addition, Mr. Stricklin had been secretary of the Reclamation Commission and the Hydroelectric Commission and a member of other conservation boards including the Columbia Basin Compact Commission. He was a past-president of the Association of Western State Engineers.

Henry W. Tabor (A.M. '27), age 60, engineer for the U. S. Bureau of Reclamation at Denver, Colo., died on November

(*Continued on page 98*)

Laclede Reinforcing Bars

... the "backbone" that gives strength and support to St. Louis' amazing new Airport Terminal Building

A bold new approach to airport terminal design has made the unusual structure pictured above, now being completed at St. Louis' Lambert Municipal Airport, a sensation in the architectural and construction world.

The obvious focus of attention is the massive but graceful roof, formed of huge intersecting cylindrical shells of concrete, 120 feet wide but only 4½ inches thick. The illusion is one of lightness and airiness, belying the roof's actual weight of 3,000 tons.

Because there are no internal supports, inherent strength is of special importance in a building of this type.

Much of that strength is provided by the use of Laclede Multi-Rib Round Reinforcing Bars, not only in the roof but throughout the entire terminal.

These Laclede-designed bars represent the perfect balance between high strength and maximum anchorage, and are enjoying ever-widening use by contractors throughout the nation.

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Leinweber, St. Louis
Structural Engineer:
William C. E. Becker, St. Louis
Engineering Consultant:
Roberts & Schaefer Co., Chicago
Contractor:
L & R Construction Co.,
St. Louis

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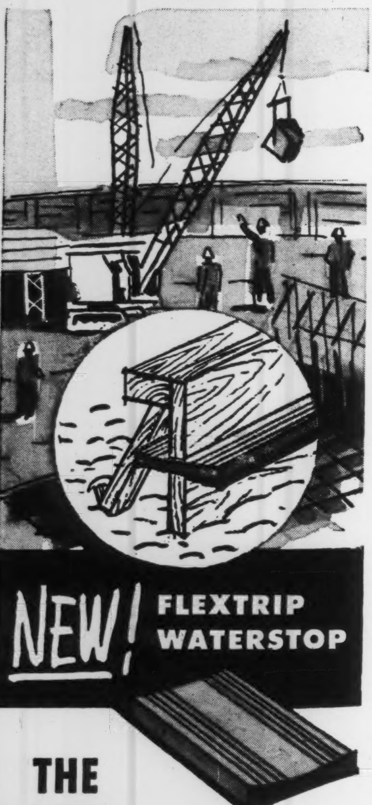

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Company________________

Address________________

City________ Zone____ State____

Deceased

(*Continued from page 88*)

30. Mr. Tabor received his B. S. degree and did graduate work at the University of Wisconsin receiving a C. E. degree in 1921. Before joining the Bureau of Reclamation, with which he was connected for thirty years, Mr. Tabor worked for several West Coast firms. He worked for the Southern California Edison Co. for six years and taught for a number of years at the University of Wisconsin. Since 1946 he had been head of the Spillways and Outlet Works Section of the Bureau of Reclamation's Dams Branch at Denver.

Eli Monie Viner (A.M. '27), age 64, supervising structural engineer for the Army Corps of Engineers, at Boston, Mass., died on November 21. A graduate of Brown University, class of 1914, Mr. Viner worked for a number of years for Jenks & Ballou, Consulting Engineers of Providence, and had a private practice there. More recently he was connected with the Army Engineers Corps as chief of the design engineering section in the Boston office. Mr. Viner was a resident of Providence where he settled in 1924.

Henry K. Vogel (J. M. '49), age 33, engineer of the Webster Manufacturing Co., Chicago, Ill., died on January 4. Mr. Vogel started to work for the Webster Manufacturing Co. in 1949 upon his graduation from the University of Illinois. He was a native of Chicago.

Michael Anthony Volino (A.M. '52), age 44, project engineer for the Arthur A. Johnson Corp., New York City, died on December 27. After graduating from the Polytechnic Institute of Brooklyn in 1932, Mr. Volino worked as field engineer for the Town of Brookhaven L. I. In 1939 he joined the Arthur A. Johnson Corp. as field engineer, and in 1945 became project engineer. At the time of his death he was project engineer in the New Rochelle area for the company's New England Thruway work. During the war he was lieutenant in the navy and later returned to the New York firm.

Carl Hawley Watson (M. '30), age 68, died at New Hyde Park, N. Y., on November 28. Mr. Watson, who retired nine months ago, was for many years president and general manager of the Gregory Coal & Lumber Co., of Great Neck, N. Y., which he joined as president in 1919. In addition, since 1927 he had served as designing and supervising engineer of the Great Neck and Belgrave Board of Sewer Commissioners. Mr. Watson graduated from Cornell University in 1910.

Ferdinand J. Weinert (A. M. '14), age 76, of St. Louis, Mo., died on November 22. Mr. Weinert graduated from the St. Louis Manual Training School of Washington University in 1897. Joining the Banner Iron Works of St. Louis in 1901, Mr. Weinert became sales manager of the structural steel division in 1925 and engineer in charge of estimating, design, and detailing of erection in 1940.

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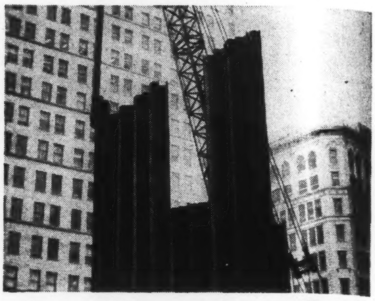

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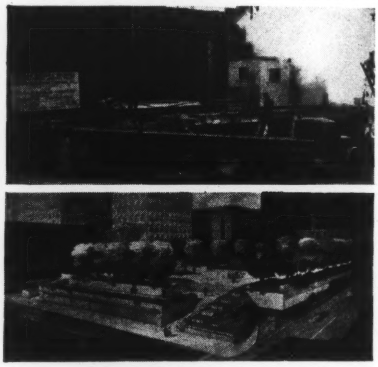

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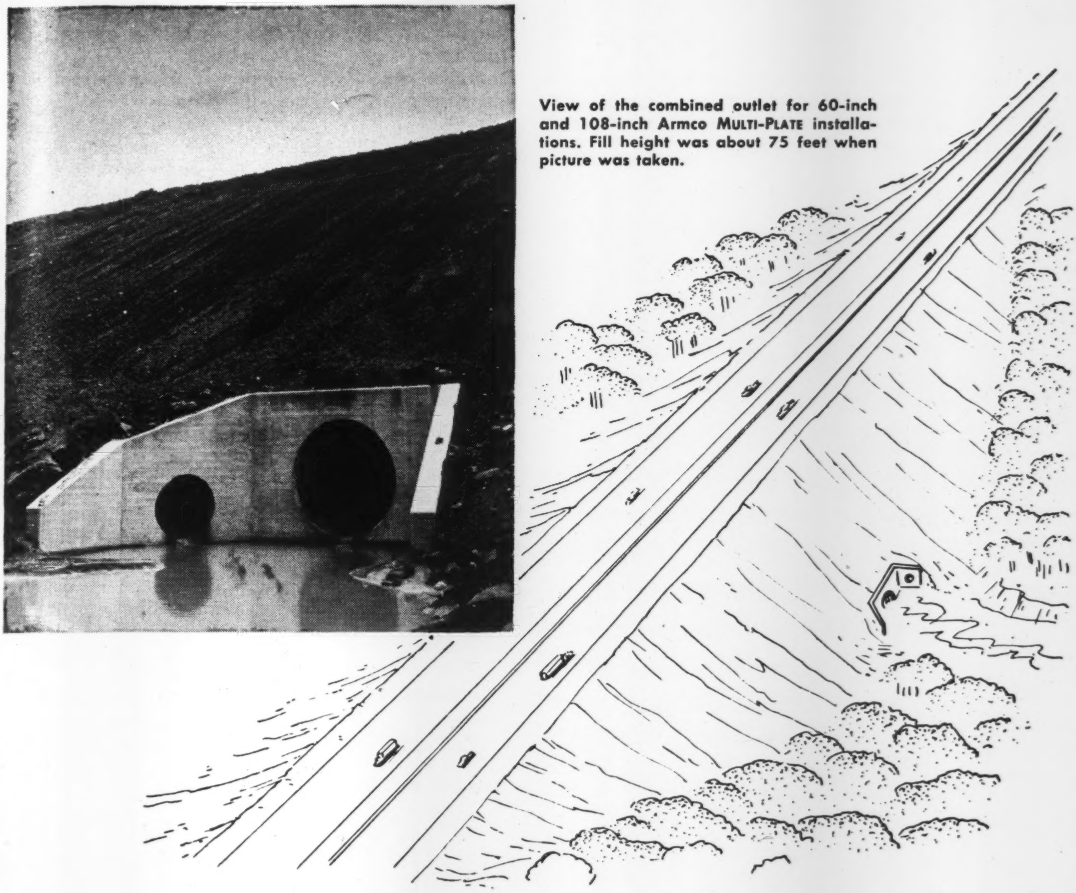


View of the combined outlet for 60-inch and 108-inch Armco MULTI-PLATE installations. Fill height was about 75 feet when picture was taken.

FLEXIBLE ARMCO PIPE HANDLES OHIO TURNPIKE'S HIGHEST FILL

The highest fill on the Ohio Turnpike—110 feet—is located just east of the Turnpike's highest bridge, crossing the Cuyahoga River. More than a quarter of a mile of Armco Corrugated Metal Structures carry drainage through this fill.

One line of 108-inch diameter Armco MULTI-PLATE Pipe runs 516 feet, directly under the Turnpike. A smaller pipe, 980 feet long, drains another area further east. This line runs diagonally through the fill to the same outlet.

Even under the tremendous earth load of high fills like this, Armco Corrugated Metal Pipe remains structurally sound. There is no danger of cracking or breaking. Thanks to flexible, corrugated metal design, loads are distributed around the entire periphery of the pipe instead of being concentrated top and bottom as with rigid pipe. Long service life is assured.

Armco Drainage Structures are available in a wide range of sizes, gages and shapes. It is easy to get the right structure to meet your specific needs. Write us for data. Armco Drainage & Metal Products, Inc., 3715 Curtis Street, Middletown, Ohio. Subsidiary of Armco Steel Corporation. In Canada: write Guelph, Ontario. Export: The Armco International Corporation.

ARMCO DRAINAGE STRUCTURES

ARMCO ®

Engineering education . . .

(This article begins on page 43)

complaint relative to surveying. Surveying has been cut to a bare minimum, especially field work. I doubt if we are teaching more than a third of the field work we were forty years ago. Educators feel that the techniques of field work can be learned best in the field after graduation. A curriculum cannot be built on the needs of an individual employer; rather it must be built on what is best for the greatest number of students and for the profession over a long period of time. If there is general dissatisfaction with the amount of surveying being taught, the question is not only, "Should we have more?" but also, "What should it replace?"

The time allotted to basic English has been greatly reduced. Of course, the addition of courses in speech and technical writing has helped but not nearly enough to offset the benefits derived from the study of a foreign language for four to six years in high school and college. There is no space here to discuss why these changes have been made, but the logical conclusion is that they have lowered the student's ability to write good English and probably to speak it.

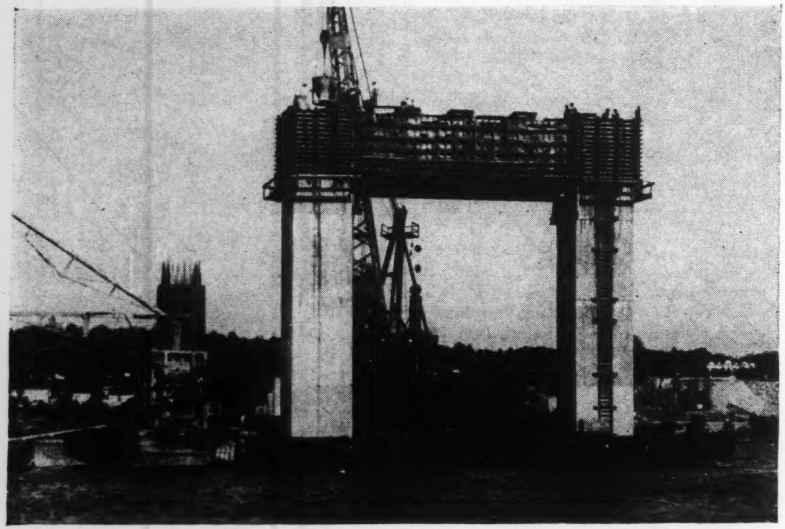
The time spent on Elementary Drafting has been cut by one half. The time spent on detailing structures has been cut as much or more. I believe that the detailing instructor of forty years ago was inspired by the idea that he was teaching his students to detail in a manner which would be acceptable to most employers. While the instructor of today hopes that what he is teaching may be practical, the primary purpose of the courses, or parts of courses, which require detailing is to emphasize the necessity for accurate and detailed conclusions. This is an attitude without which the student cannot become an engineer.

Long-range development is goal

Since the young graduate deals largely with elementary detail during his first years of employment, the trend in education makes the graduate of less immediate value to his employer, while giving him a better background for future development. Whether this is good or bad depends largely on the attitude of the employer. Deficiencies in English, drawing, or surveying may be noticed first by the employer. Recent trends have not been favorable for immediate good performance in these areas. In an effort to crowd more into a four-year curriculum, it has seemed best to cut the techniques to a minimum in favor of basic science, advanced theory, and the humanities.

Another trend today is to develop faculties in which many of the members are interested in research. This means that instructors will lean towards the theoretical rather than the practical. This trend appears to be good for the profession as a whole over a long period of time. However, it presents something of a handicap to the young graduate if his employer insists on immediate proficiency in elementary surveying, drafting, or structural detailing, and places no value on the young man's knowledge of differential equations or advanced hydraulic theory.

Every employer and every one who works with young graduates should understand their background and be patient while they learn the application of the theory they have been taught to routine elementary engineering problems. If employers will do this, they will discover that these same young men, whose education seemed deficient at first, will advance rapidly and show themselves well qualified to go far up the ladder in their profession. Their ceiling will be limited more likely by personal characteristics than by technical qualifications.



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BITUMULS IS ASPHALTIC BINDER IN EMULSION FORM. Applied cold, it bonds well with every type of clean surface; it thoroughly coats all types of aggregates, wet or dry. It can be used in damp weather and even at relatively low temperatures. For the deep penetration required on trench repair (above), Bitumuls has no equal.

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There are Bitumuls Engineers who work out of offices near you. Call on them whenever you feel that they can assist on maintenance problems.

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CONCRETE SUPPLIER Herbert Kneller, v.p. and general manager of the Ezra Stipp Construction Co., Scranton, Pa., reports: "Our customers show a preference for ready-mixed concrete made with Duraplastic cement. That's why we've used it since it was first introduced. Experience has shown that Duraplastic produces excellent results for almost every type of construction work."

WELL-KNOWN BUILDER D. W. Richardson, president of the R. D. Richardson Construction Co., Scranton, Pa., also recommends Duraplastic. "Duraplastic gives us a more workable, plastic mix," says Mr. Richardson. "This means we get better placing and appearance at lower cost to us."

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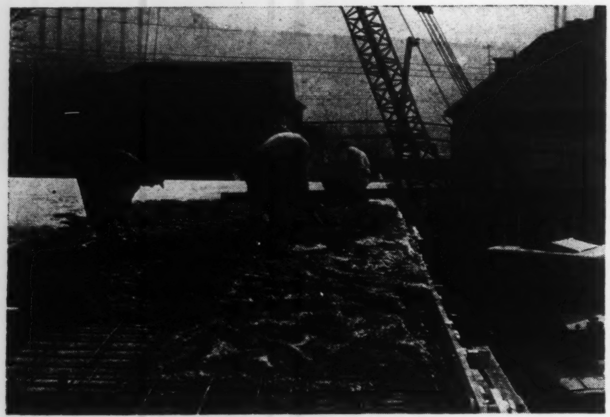

WORKABLE CONCRETE made with Duraplastic facilitates placement work in construction of this type. Workmen find it easy to place Duraplastic concrete properly around steel reinforcing.

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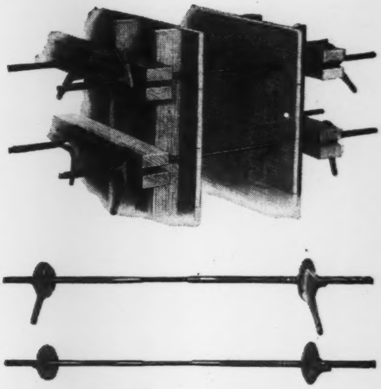
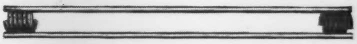
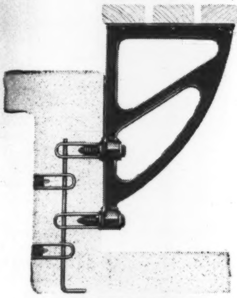


TILT LOCK CLAMPS

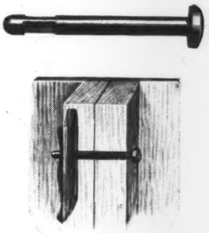
SNAP TIES



STANDARD COIL TIES



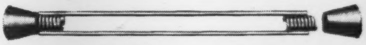
RISERFRAMES



PANEL LOCK BOLTS

PAT No 2190838

ROD CLAMPS



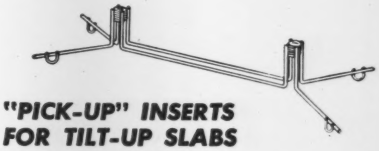
CONE-FAST COIL TIES

COIL LOOPS

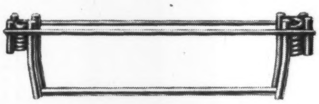
SCREW ANCHORS AND BOLTS

STANDARD HANGER FRAMES

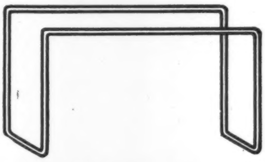
ADJUSTABLE SCREED CHAIRS



"PICK-UP" INSERTS FOR TILT-UP SLABS



SPECIAL HANGER FRAMES



WIRE BEAM SADDLES

Shown here are some of the many types of Form Ties, Anchors, and other concrete accessories which SUPERIOR'S years of engineering and field experience plus manufacturing dependability have developed and produced.

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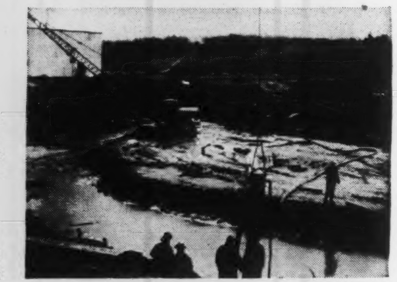

QUAKY SOIL—fine alluvial silt overlying bedrock — was a hazard confronting General Electric and A.E.C. Vibration of excavating machinery made soil fluid, caused collapse of test hole.

A VACUUM WELLPOINT system, by Griffin, solved the rare type of problem involved. Removal of small amounts of water (only 20 gpm)—this plus high vacuum was enough to make soil stable—even to stand at slopes as steep as 1½ on 1 (See photo).

THE SKILLS of the wellpoint engineers were taxed in many ways. A vacuum system is itself complex. The sand filters required special techniques. Though part of subgrade lay 25 ft below ground water, a multi-stage system was avoided—by working with header line *below* natural water table.

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New Publications

Thin Concrete Shells. Papers by a group of leaders in the field of shell structures make up the the recently published Proceedings of the Conference on Thin Concrete Shells, held at Massachusetts Institute of Technology, June 21–23, 1954. The compilation, which includes contributions on architectural, design, and construction aspects of the subject, sells for $5, postpaid in the United States. Inquiries should be sent to Miss Jean E. Murray, Room 1–250, Massachusetts Institute of Technology, Cambridge 39, Mass.

Mississippi River Stages. Detailed Mississippi River stream-gaging records for 1953 are available in a 296-page publication announced by the Mississippi River Commission. The paper-bound volume includes daily gage records and daily observed river discharge records at stations operated by district offices of the Corps of Engineers and other agencies. Copies, priced at $1 each, may be purchased from the Office of the President, Mississippi River Commission, P.O. Box 80, Vicksburg, Miss. Checks should be made payable to the Treasurer of the United States.

Testing Laboratories. Information on 278 commercial and 86 college laboratories equipped to undertake testing on a commercial basis is given in a 48-page *Directory of Commercial and College Testing Laboratories* issued by the American Society of Testing Materials. A successor to Miscellaneous Publication M 187 of the National Bureau of Standards, published in 1947, the present directory includes testing for air pollution, industrial waste, and similar factors as well as the standard testing of commodities. Copies are available from the American Society for Testing Materials, 1916 Race Street, Philadelphia 3, Pa. The cost is $1.

Construction Review. The first issue of *Construction Review*, which consolidates the monthly publications of the Departments of Labor and Commerce, made its appearance in January. The improved and modernized publication gives virtually all current government statistics pertaining to the construction industry, plus information from some non-government sources. It also promises articles on specific aspects of construction, including interpretation of trends, outlook, and special studies. Copies are for sale by the Superintendent of Documents, U.S. Government Printing Office, Washington 25, D.C., at 30 cents each. The subscription price is $3 a year domestic, and $4 foreign.

Construction Standards. What technique is expected to save the building industry millions of dollars? This and many other questions important to the builder, the buyer, and the real estate man are answered by experts in the Proceedings of the Fifth National Conference on Standards, which was held in New York in November. Entitled *Standards for a Stronger America*, the 100-page volume is available from the American Standards Association, 70 East 45th Street, New York 17, at $3.

Subsurface Studies. An important aid in the solution of subsurface geologic problems in Wisconsin has been made generally available with publication of the work of two University of Wisconsin geologists, which comprises Bulletin 78 in the Wisconsin Geological Survey Series. The report details a four-year study showing the degree to which geophysical studies can be of assistance in resolving some of the problems of subsurface water supply, mineral exploration, engineering, and subsurface geology encountered in the state. Copies, priced at $2 each, are being sold through the Office of the State Geologist, Science Hall, University of Wisconsin, Madison, Wis.

United States Maps. Availability of new editions of United States maps—*Status of Topographic Mapping, Aerial Photography*, and *Aerial Mosaics*—is announced by the U.S. Geological Survey. The maps show all areas covered by topographic maps produced by the Geological Survey and other federal agencies, new mapping in progress, and all areas covered by aerial photographs obtained by or for federal, state and commercial agencies. Copies may be obtained without charge on request to J.O. Kilmartin, Chief, Map Information Office, U.S. Geological Survey, Washington 25, D.C.

Truss Design. Time savers in the form of tables to aid in designing trusses have been prepared by W.H. Evans, A.M. ASCE, and C.W. Matthews, J.M. ASCE, who will sell copies at cost—30 cents. Inquiries should be addressed to Mr. Evans at 61 Park Plaza, Daly City, Calif.

Examinations, California. A revised and enlarged (287 pages) book covering examinations given by the State of California for the registration of civil engineers and engineers in training may be obtained from the author, August E. Waegemann, J.M. ASCE, 2833 Webster Street, San Francisco 23, Calif. For part of the period covered (1940–1953) the author has provided unofficial solutions to the examinations given. Copies, priced at $7 each plus tax, will be sent postpaid, or C.O.D., plus postage.

Resources for the Future. The need for research and education in the social sciences to match technological advances in development, conservation, and use of natural resources is emphasized in the recently issued annual report of Resources for the Future, Inc. The 36-page report covers the work of the organization for the year ending September 30, 1954. Inquiries should be addressed to Resources for the Future, Inc., 1145 Nineteenth Street, N.W., Washington 6, D.C. Also available is the final report of the Mid-Century Conference on Resources for the Future, held in Washington in December 1953. Entitled *The Nation Looks at Its Resources*, the 418-page, paper-bound report sells for $5.

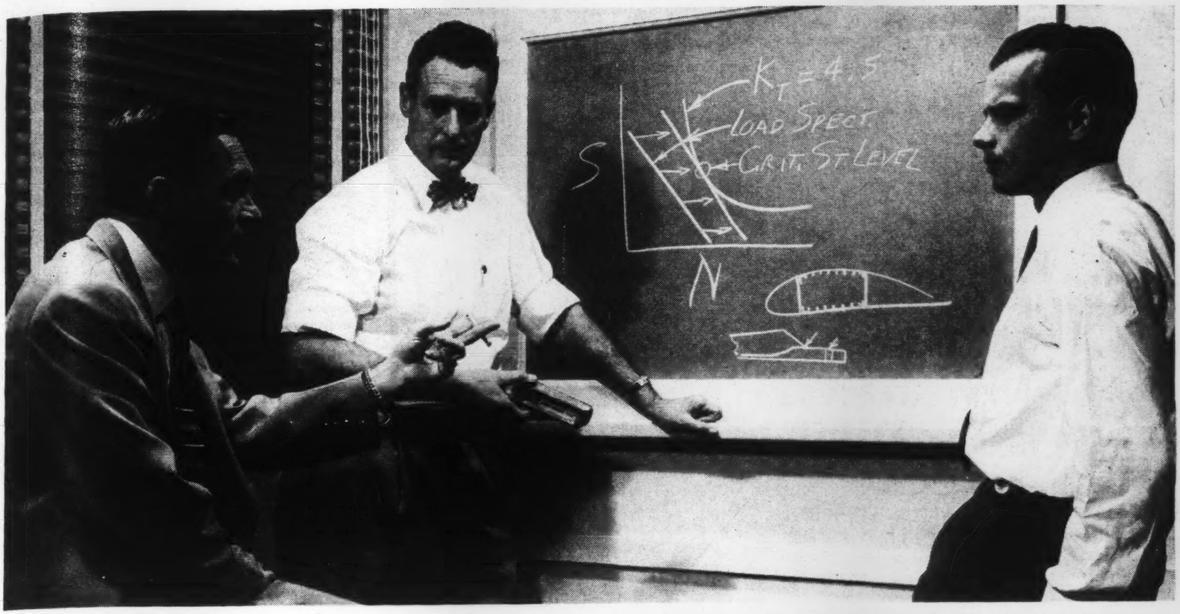
Pollution Control. Sewage-disposal facilities to purify waste from a population of more than 4,000,000 are now in operation in the Ohio Valley, and new facilities under construction or approved will treat the sewage from another 3,260,000 persons. This is part of the story of pollution-control developments revealed in the sixth annual report of the Ohio River Valley Water Sanitation Commission, which has been presented to the governors of the eight states who are joined in a regional campaign to secure clean streams. Inquiries concerning the report should be sent to the Commission, 414 Walnut Street, Cincinnati 2, Ohio.

Manpower Policy. Improved vocational guidance with the aim of encouraging more young people to become skilled workers and technicians inspired a 50-page report on the subject issued by the National Manpower Council in December. The Council, which is financed by the Ford Foundation, was established at the Columbia University Graduate School of Business by President Eisenhower when he was head of the university. Inquiries should be addressed to the National Manpower Council, Graduate School of Business, Columbia University, New York, N.Y.

Highway Studies. A considerable range of information on road equipment is covered by the American Road Builders Association in a *Symposium on Road Equipment*, recently issued as Technical Bulletin No. 209 and priced at $1.50. Other valuable ARBA publications include Bulletin No. 208, consisting of three articles on soil-cement and selling for 50 cents; Bulletin No. 210, which reports the Proceedings of the Annual Meeting of the ARBA Educational Division and costs 75 cents; and Bulletin No. 211, which details an ARBA committee report on winter maintenance of roads and is priced at 50 cents. ARBA members are entitled to one free copy upon request. Copies may be obtained from the ARBA, World Center Building, Washington 6, D.C.

Soil Surveys. Issuance of a series of reports on soil conditions in each county of New Jersey—for use by highway engineers in locating and relocating road alignments and in finding material suitable for fills—is announced by the Joint Highway Research Committee, which has its headquarters in the Rutgers University College of Engineering, New Brunswick, N. J. Currently available are reports for Essex, Passaic, Bergen and Hudson, Union, Hunterdon, and Somerset counties, priced at $1 each, and for Ocean, Morris, Middlesex, Sussex, Mercer, Warren, and Salem counties, at $1.50 each. Also available are Report No. 1 on Environment and Research Procedures, which is $1.50, and "Dynamic Compaction of Soil," by R. K. Bernhard, which is $1.

(*Continued on page 106*)



J. F. McBrearty, chief structures engineer (left), discusses fatigue test program of integrally-stiffened wing lower surface structure of Super Constellation Model with E. H. Spaulding, structures division engineer and J. G. Leewolt, stress engineer. Lockheed's 500,000 lb. Force Fatigue Machine was used in test program.

Advanced structures facilities speed careers of Lockheed Engineers

Engineers in Lockheed's Structures Division are supported by unmatched research and testing facilities in their constant effort to increase strength while decreasing weight.

Among those facilities are the Lockheed-designed 500,000 Lb. Force Fatigue Machine, first of its size; Shimmy Tower, only one in private industry; and Drop Test Tower, largest in the nation.

Facilities such as these give engineers a major advantage in making technical advances – and thus advancing their careers. Moreover, the large number of projects always in motion at Lockheed mean continuing opportunity for promotion as well as job security.

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Ralph Oliva, research engineer, examines Super Constellation skin for signs of fatigue failure.

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2. New studies in: Effect of high temperatures on structures; optimization of thin-wing designs and other aero-elastic problems; new materials such as ultra-high heat treat steel; panel instability at extremely high speeds.

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Name...
Membership Grade.......................................
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New Publications

(Continued from page 104)

Construction Management. Availability of a Bibliography on *Management of Construction Jobs*, listing references to articles dealing with construction job planning, work scheduling, cost, organization, material-requirement charts, material-delivery time and contracting procedures on various jobs is announced by the Engineering Societies Library. Identified as Bibliography No. 8, the listing may be purchased from the Library, 29 West 39th Street, New York 18, at $2 a copy.

Pollution Control. Procedures for analyzing metal-finishing wastes are outlined in a recent manual published by the Ohio River Valley Sanitation Commission in cooperation with its Metal Finishing Industry Action Committee. The 108-page report provides methods for screening out substances which cause interference in the use of commonly accepted analytical techniques. Copies, priced at $1, are available from the Commission, 414 Walnut Street, Cincinnati 2, Ohio.

Structural Steel. To assist all concerned with the planning, financing, and construction of schools, the American Institute of Steel Construction has prepared a booklet showing the successful use of steel framing in different types of school structures and in various geographical locations where physical requirements differ. For free copies write to the AISC, 101 Park Avenue, New York 17, N.Y.

Cement, Standards. The most recent edition (1954) of the ASTM Standards on Cement brings together in compact, readily usable form test methods, specifications, and definitions used in the field. Prepared by ASTM Committee C-1 on Cement, the 254-page book, in heavy paper cover, can be obtained from the American Society for Testing Materials, 1916 Race Street, Philadelphia 3, Pa., at $2.75 each.

Timber. Common misconceptions about timber construction are cleared up in an interesting booklet written by Verne Ketchum, M. ASCE, chief engineer of Timber Structures, Inc., Portland, Oreg. Free copies of the publication, entitled *Fact or Fiction*, are available from Timber Structures, Inc., P. O. Box 3782, Portland.

Technical Dictionaries. In a recently published *Bibliography of Interlingual, Scientific and Technical Dictionaries*, UNESCO lists 1,629 dictionaries and glossaries which give the equivalent in two or more languages of technical terms relating to any of 237 different branches of the natural sciences and their application in engineering and technology. The listing also shows which dictionaries provide translations for which of 75 different languages. Copies are $1.75 each, and may be obtained from all UNESCO sales agents or from the Columbia University Press, 2960 Broadway, New York 27, N. Y.

Pollution Control. To bring its *Water Quality Criteria*, issued in 1952, up to date, the California State Water Pollution Control Board early in January published Addendum No. 1 to it. The new 164-page publication includes a critical review of the work represented in the 1952 report, necessary errata, and abstraction and evaluation of technical data published during 1952 and 1953 (some 371 new references). Copies of Addendum No. 1 are for sale to those who purchased the 1952 edition at $1.50 a copy, postpaid but not including the 5 percent sales tax which must be added for California addresses. Payment should accompany orders to the Documents Section, State Water Pollution Control Board, 721 Capitol Avenue, Sacramento 14, Calif.

[*Editor's Note*: Copies of the Los Angeles County Flood Control District's *Biennial Report on Hydrologic Data* (No. 146) for the 1951–1952 and 1952–1953 seasons—reviewed briefly in the November issue, page 111—may be referred to in the following libraries: U.S. Weather Bureau Library, 24th and M Streets, N.W., Washington 25, D.C.; Documents Section, California State Library, Sacramento 9; Los Angeles County Public Library, 322 South Broadway, Los Angeles 13; Los Angeles City Library, 630 West Fifth Street; and Los Angeles City Municipal Reference Library, 300 City Hall. They are not available for general distribution, as implied in our review.]

Non-ASCE Meetings

American Society for Metals. Ninth Western Metal Exposition at the Pan-Pacific Auditorium, and Ninth Western Metal Congress at the Ambassador Hotel, Los Angeles, March 28–April 1. Co-sponsors are the American Society for Metals and twenty-four other technical societies. Registration for the exposition free to members of any of the sponsoring societies.

American Society of Mechanical Engineers. Engineering Management Conference at the Hotel Statler, Cleveland, Ohio, March 23–24.

Annual Water Symposium. Sponsored by Louisiana State University at Pleasant Hall, Louisiana State University, Baton Rouge, La., March 22–23. Registration fee $8.00 including banquet. Information from J. W. Brouillette, Director, General Extension Division, L.S.U., Baton Rouge 3, La.

Associated General Contractors of America. Thirty-sixth Annual Convention in New Orleans, La., March 14–17. Information from AGC headquarters, Munsey Building, Washington 4, D.C.

Atomic Industrial Forum. Atomic Industry Conference at the Mark Hopkins Hotel, San Francisco, Calif., April 4–5. Co-sponsors are the Stanford Research Institute and Atomic Industrial Forum, 260 Madison Ave., New York City.

Better Concrete Conference. Sponsored by Iowa State College at Memorial Union, Iowa State College, Ames, March 17-18.

Biological Waste Treatment. Conference sponsored by Manhattan College, at Manhattan College, April 13–15.

International Commission on Large Dams. Fifth International Congress in Paris, France, and North Africa, May 23–June 12. Deadline for registration, March 18. Notify J. W. Stanley, Secretary-Treasurer, U.S.C.O.L.D., P.O. Box A-A, Boulder City, Nev.

National Air Pollution Symposium. Third Symposium at the Huntington-Sheraton Hotel, Pasadena, Calif., April 18-20. Sponsors are Stanford Research Institute, California Institute of Technology, University of Southern California, University of California, Southern California Air Pollution Foundation and the Air Pollution Control Association.

Municipal and Health Engineering Conference. Sponsored by the Engineering and Industrial Experiment Station and the Agricultural Engineering Department of the University of Florida and the State Board of Health, at Gainesville, Fla., March 15-16.

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1927—Covering wing of early Boeing plane, Seattle plant

1955—B-47 Stratojet assembly, Boeing Wichita Division

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Men Available

Civil Engineer; A.M. ASCE; 36; married; B.C.E. 1940, graduate work '42, '48; P.E.(Wisconsin, New York); 14 years' diversified experience as structural engineer: steel and concrete construction of industrial plants, multistory buildings and warehouses; field and construction surveying and supervision. Presently president of small manufacturing plant employing 70 people. Desires permanent position with managerial responsibilities. Location preferred: Wisconsin but will relocate. C-26-30-CE; Chicago.

Foreign Position; M. ASCE; 45; single; experienced Australian Civil, Mechanical, Electrical Engineer; completed Master's degree in Petroleum; fifteen years supervision heavy construction in Australia, England, India, Middle East, Central America, including oilfield plants, pipelines, pump stations, harbour terminal installations; excellent health; desires responsible foreign position. C-26.

Civil Engineer; M. ASCE; 67; married; New York State P.E. and L.S.; 50 years' diversified experience as engineer, superintendent, office manager, estimator including cost work and purchasing on heavy construction, water supply, gas plants and electric generating stations, shops, office buildings, etc.; desires full time or part time office work in general contractor's or consulting engineer's organization. Location preferred, New York Metropolitan area. C-28.

Construction Engineer; J.M. ASCE; 27; single; willing to travel; six years' experience in highway and bridge construction (two as Project Engineer). Desires position with consultant or contractor. C-29.

Soils Engineer; J.M. ASCE; 30; married; B.S.C.E.; Registered California; six years' experience in all phases of applied soil mechanics and foundation investigations, the last three years in a supervisory capacity. Desires responsible position, design or construction, preferably not in a large city. Will relocate. C-30.

Civil Engineer; J.M. ASCE; M.C.E. '47; 32; P.E. California; married; one year instructing; five years' professional experience in petroleum industry and airfield planning; one year sales and one year administrative experience in lumber industry. Desires permanent position leading to managerial responsibilities. C-31-107-A-San Francisco.

Civil Engineer; J.M. ASCE; P.E. (New York); eight years' diversified design experience for chemical plants and oil refineries—steel, concrete (including rigid frame analysis), heavy foundations, servers; heating and plumbing systems; plant layout including buildings, roads, R.R. sidings. Desires position affording increasing scope with good advancement potential. Will relocate. Foreign assignment considered. C-32.

Positions Available

Instructor; civil engineering; M.S. degree and some experience in teaching required. The appointment would be for three years, round-trip expenses would be furnished and maintenance would be provided. Position available in the fall of 1955. Location, Near East. F-856.

Civil Engineer; experienced in design of sewerage system and sewerage treatment plants. Salary, $6,240 or better depending on applicant. Location, Connecticut. W-859.

Instructor or Assistant Professor; M.S. in civil engineering; to teach surveying, soil mechanics, fluid mechanics and normal civil engineering laboratories. Should be active in technical and professional organizations. Salary and academic rank open. Position starts September 1955. Location, Midwest. W-868(a).

Junior Engineers; civil graduates; under 26; with above average academic records. Veterans with no practical experience will be considered. Applicants must be willing to relocate. Salary open. Location, Pennsylvania. W-910.

Instructor; civil engineering; preferably with M.S. degree; practical or teaching experience; major interest, sanitary engineering, desired but not required. Position open in the fall of 1955. Location, Midwest. W-923.

Sales Representative; 28-35; civil or mechanical graduate; with metal sales experience in building materials field, to call on architects, engineers and contractors covering design, installation, specifications, costs, etc., for aluminum projects. Salary, $6,000-$8,000 a year. Location, New York, N. Y. W-927.

Engineers (*a*) Sanitary Engineer; with five to ten years' experience to take charge of design and making general layouts, as well as supervising other draftsmen. Salary, $7,200-$8,400 a year. Location, western Pennsylvania. (*b*) Resident Engineers; residence required at the site of operations, mostly in and around Pennsylvania. Salary, $7,800-$8,400 a year. W-945.

Design Engineer; civil graduate; 35-50; with at least five years' design and layout of road construction, drainage facilities and general site adaptation on airfield project. Salary, $9,600 a year plus $12 a day living allowance. Duration six months. Location, France. F-956.

Structural Designer; civil graduate, with at least eight years' reinforced concrete and structural steel design experience covering industrial and process construction. Salary, $6,240-$7,280 a year. Location, New York, N.Y. W-968.

Structural Engineer; to design and supervise the design of miscellaneous steel, concrete and timber structures. Salary, $6,700 a year, plus fringe benefits. Location, New England. W-977.

Instructor; civil engineering graduate; young; preferably with M.S. degree; for eight and a half months school year. Salary, $4,000 a year. Location, Pennsylvania. W-979.

Structural Design Engineer; graduate; 30-50; with seven to eight years' experience, three of which were in the design of steam power stations. Will design both structural steel and reinforced concrete and make a presentable drawing. Location, western Pennsylvania. W-983.

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Instructor; civil engineering; M.S. degree; with some practical experience to teach the fields of transportation and surveying. Salary, $3,600–$4,750 for nine-month academic year. Compensation for summer work. Location, Pennsylvania. W-989.

Design Draftsman; preferably civil graduate; with four to six years' experience covering design and layout of industrial buildings. Salary, $6,600–$6,900 a year. Location, New York, N.Y. W-995.

Superintendent; 40–55; for a large sewage treatment plant, an intercepting sewer system, and district and main sewage pumping stations; some previous experience as superintendent. Must have or be able to obtain a New Jersey grade A operator's license. Location, southern New Jersey. W-1009.

Instructor; with B.S. degree; to teach surveying and general civil engineering subjects in a junior college. Salary, $4,000–$4,500 a year. Location, New Jersey. W-1022.

Chief Engineer; to take charge of all new design and construction, replacement of worn and obsolete equipment; must know about the operation of water softening plants and sewage treatment plants. Salary, about $10,000 a year. Location, South. W-1033.

Assistant Director of Public Works; civil graduate; experience essential in street design and construction, storm water drainage and related work. Executive ability desirable. Salary, $7,200 a year. Location, South. W-1047.

Construction Superintendent; civil graduate; with considerable experience on concrete foundations and superstructures for industrial plants. Salary, $7,800–$9,000 a year. Location, South. W-1057(a).

Water Utility Executive; civil or mechanical graduate, with professional engineer's license. Experienced in hydraulics, with pumping and gravity, with large sized pipes up to 60"; surveying, with knowledge of right of way locations; standard procedure of public utility accounting. Salary open. Location, New England. W-1063.

Teaching Personnel (*a*) Instructor; young; preferably with M.S. in civil engineering. Salary open. (*b*) Assistant or Associate Professor; with at least M.S. in civil engineering and considerable training and experience in various aspects of highway engineering. Salary open. Positions available fall of 1955. Location, Midwest. W-1073.

Structural Engineer; with steel and timber design and construction experience to supervise layouts, prepare specifications and estimates covering cooling towers, supports, and pumping equipment. Salary, $5,200–$6,500 a year. Location, New York, N.Y. W-1087.

Structural Engineers; B.S. or equivalent experience; 35–50; married; with eight to ten years' experience in structural and architectural engineering design; capable of heading design group. Prefer experience in industrial type work. Will calculate and design structural steel, concrete foundations for industrial equipment of buildings, write requisitions and material takeoff, check fabrication drawings, etc. Salary up to $8,400 a year depending on experience. Employer will pay fee. No traveling. Location, Chicago. C-2576(a).

Sales Engineer; structural steel; C.E. or M.E. graduate with five years' experience in detailing and checking structural steel. Must have structural license and a knowledge of engineering and estimating. Will do detailing, estimating and selling structural steel products and fabrications. Salary, $6,240–$7,800 a year. Employer will negotiate fee. Location, Indiana. C-2577.

Executive Structural Steel Detailer; college graduate; 30–45; with five to ten years' experience in making shop detail drawings for structural steel for industrial buildings, schools, bridges, etc. Knowledge of supervising detail drawings made by three or four men in office and three or four outside detailers; some actual drawing board work. Occasional consultation with customer architects-engineers. Must have personality to be administrator of engineering work. Structural engineer state license desirable or ability to get one. Salary, $10,000 or more. Employer will negotiate fee. Location, Chicago. C-2596.

Specifications and Technical Writer

Engineering degree and responsible experience in writing specifications for heavy construction work. Must have ability to correlate specifications for incidental architectural, mechanical, and electrical phases into complete specifications.

For established engineering consultants with international operations, located on Gulf Coast.

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Civil Engineering
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New York 18, N. Y.

Applications for Admission to ASCE, January 29, 1955–February 5, 1955

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Charles Henry Alban, Jackson, Mich.
Thomas Lyndon Bennett, Chattanooga, Tenn.
Richard Arns Boettcher, Altadena, Calif.
Alfred Thomas Brown, Dallas, Tex.
Virgil Claude Bryant, El Centro, Calif.
John Joseph Burns. Philadelphia, Pa.
David Cohen, Providence, R.I.
John Burrud Cory, Jr., Oak Ridge, Tenn.
Clifford James Geertz, San Francisco, Calif.
Albert Harrison, Middletown, Ky.
Archie Vincent Hillery, Ada, Ohio.
Syed Mohammad Irfanallah, Karachi, Pakistan.
Carl Hamilton Johnson, Chicago, Ill.
Bernard Chandler Jordan, Jr., Natchez, Miss.
John Jacob Konrad, Huntington, W.Va.
David Peterson Miller, Rock Springs, Wyo.
Wallace Tiffany Miller, Chicago, Ill.
T. Mark Radcliffe, Helena, Mont.
George Andrew Rezac, San Francisco, Calif.
Louis Thomas Shannon, Pittsburgh, Pa.
John Barr Shuler, Maracaibo, Venezuela.
Donald Wilbert Smith, Seattle, Wash.
Stephen Elliott Smith, Baltimore, Md.
Willard Henry Stevenson, Fort Wayne, Ind.
Samuel Turley Stinson, Huntington, W.Va.
Walter Alfred Henry Watts, London, England.

Applying for Associate Member

Mahmoud Said Abdallah, Cairo, Egypt.
Wahid Uddin Ahmad, Dacca, East Pakistan.
Loren Merle Barnett, San Bernardino, Calif.
Robert William Beatie, Kansas City, Mo.
Bill Kirk Bramble, San Diego, Calif.
Edward Russell Brown, Dallas, Tex.
Sterling Grant Brisbin, Stamford, Conn.
Richard Works Chaney, Bishop, Calif.
Chiao-Lin Chang, Pittsburgh, Pa.
Gordon Manuel Corbin, Flagstaff, Ariz.
Anil Kumar Das Gupta, Calcutta, India.
John Ernest Leopold De Bremaeker, Essex, England.
Richard Peter Deitos, Miami, Fla.
William Ray Dotson, San Diego, Calif.
Willima Sells Dun, Oakland, Calif.
Kenneth Meeks Dunn, Keyser, W.Va.
Lloyd Earle Garst, Piru, Calif.
James Douglas Geddes, Nigeria, British West Africa.
Norman Arnold Gottlieb, Portsmouth, Ohio.
William Percy Hammerson, Palo Alto, Calif.
Herbert William Humphries, Olympia, Wash.
Chandra Kant Jha, Chicago, Ill.
Charles Francis Kain, Lansdowne, Pa.
Edward Vernon Konkel, Denver, Colo.
Donald Edward Kretzer, Dallas, Tex.
Chin Fun Kwok, New York, N.Y.
Louis Joseph Layer, San Antonio, Tex.
William Erdman Loose, Knoxville, Tenn.
Francis Koon You Mau, Oahu, Hawaii.
Malcolm Reede Meurer, Denver, Colo.
Frank Stickney Mitchell, Jr., Houston, Tex.
H. W. Reeves, Houston, Tex.
Edward James Rodden, Pittsburgh, Pa.
Max Hugo Schubert, Jr., Lemoyne, Pa.
Geoffrey Howard Smith, New Rochelle, N.Y.
Albert Charles Silbert, Camberra, Australia.
Willard Emery Sivley, Walla Walla, Wash.
James Harrison Sprouse, Jr., Big Spring, Tex.
Stephen Russell Stearns, Wilmette, Ill.
Solano Vega-Vischi, Denver, Colo.
Ernest Yehwei Wu, Hong Kong, China.
Howard Clifford Young, Washington, D.C.

Applying for Junior Member

Stanley Carl Bailey, Milwaukee, Wis.
William Louis Burle, Greenville, Miss.
John Dewey Cardall, Jr., South Pasadena, Calif.
Richard Edward Cavanaugh, Palmer, Mass.
John Cernica, Pittsburgh, Pa.
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Jack Murrey Estridge, Los Angeles, Calif.
Robert Edwin Huie, Douglaston, N.Y.
Arnold Alfred Johnson, Twin Falls, Idaho.
Robert Wallace Kirk, Perrysburg, Ohio.
Gerald Gaylord Leach, Anchorage, Alaska.
Harry Leff, Jr., San Francisco, Calif.
Robert Jesse Leininger, Kansas City, Mo.
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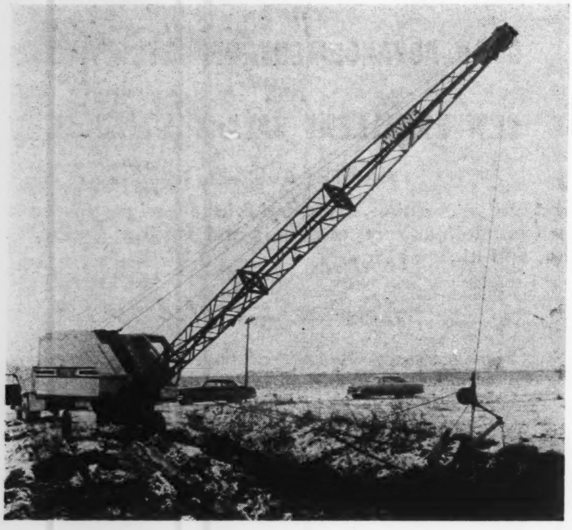
EQUIPMENT, MATERIALS and METHODS

NEW DEVELOPMENTS OF INTEREST AS REPORTED BY MANUFACTURERS

$^{3}/_{4}$ Yd Crane-Excavator Line Offers Economy Features



FROM A PIONEER MANUFACTURER IN EARTH-MOVING AND MATERIAL HANDLING EQUIPMENT COMES THE INTRODUCTION OF A COMPLETE LINE OF FULL $^{3}/_{4}$ YD CRANE-EXCAVATORS. The Wayne Shovel and Crane Division of the American Steel Dredge Company already has three of these machines in production: the $^{3}/_{4}$ yd crawler-mounted Model 70, and the $^{3}/_{4}$ yd truck-mounted Models 50A and 50B. Many economical features are built into the current Wayne $^{3}/_{4}$ yd model. It is described as a custom-made machine at production-line cost which means the buyer can specify the crane or excavator which meets his individual requirements. The basic $^{3}/_{4}$ yd machine is never hampered with unnecessary accessories and, as a result, initial investment costs are substantially lowered. However, the extra optionals, the independent boom hoist, friction-type swing lock, double-load rollers and power lowering on load line, can be added later without changing major assemblies. The basic model has been designed to make all the main wearing parts interchangeable throughout the machine. The clutch parts of the hoist drum assembly are interchangeable, in the right to left-hand position, and this is also applicable to the reversing shaft clutch assembly. Other features of the Wayne $^{3}/_{4}$ yd crane-excavator include a positive crawler lock and one lever steering control in the crawler model and a 19 ft trench hoe boom which permits a 31 ft 2 in. reach and digging depth of 20 ft 5 in. Since 1906 the American Steel Dredge Company has designed and manufactured earth-moving and material handling equipment. The Wayne Shovel and Crane Division was formed in 1942 and began the manufacture of $^{1}/_{2}$ yd power cranes and shovels. **Wayne Shovel and Crane Division, American Steel Dredge Co. Inc., CE 3-112, 2003 Taylor St., Fort Wayne 1, Ind.**

Longer Clay Pipe

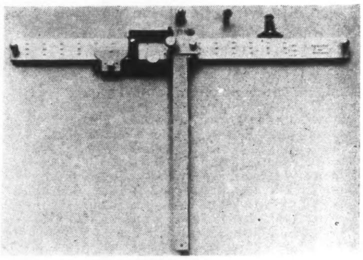
IN RESPONSE TO THE DEMAND FOR LONGER PIPE AND FEWER JOINTS, "King-Size" vitrified clay pipe, standard and extra strength, is now in production. The longer pipe is available in 5, 4 and 3 ft lengths and in Slip-Joint or regular bell and spigot types. Five ft lengths, eliminating two joints every 10 ft, are being manufactured currently in 18, 21 and 24 in. diameters of standard and extra strength. Four ft lengths are being produced in 8 through 30 in. diameters and 3 ft lengths in 4, 5 and 6 in. house connection and building-sewer sizes. Longer lengths reduce the number of joints, permitting faster installation, reducing infiltration and exfiltration and saving on man-hours and material. **Logan Clay Products Co., CE 3-112, Logan, Ohio.**

High Strength Wire Rope

A HIGH STRENGTH WIRE ROPE, WHICH IS CLAIMED TO BE 15 PERCENT STRONGER THAN THE BEST GRADE OF WIRE ROPE NOW BEING MANUFACTURED, has been announced. Representing the most important change in the characteristics of wire in 35 years, the new grade of rope is expected to simplify the use of wire rope generally and to permit lighter weight equipment to be designed at lower cost. An average tensile strength of 300,000 psi has been achieved. The preformed rope, to be known as VHS (very high strength), is already being used by the Navy for steam jet catapult launching assemblies, and for arresting gears and barriers. Present diameters of the product range from $^{1}/_{2}$ in. to 2 in. VHS cable will resist plastic deformation or the tendency to become "hide bound." Field tests of VHS drag lines and shovel hoist ropes have shown a definite decrease in breakage due to shock and misuse. In handling crushed stone, eight $1^{1}/_{4}$ in. drag cables had an average service life of 170 hours as compared with an average of 80 hours for the rope previously used. In a similar installation for trap rock, the cable handled 262,000 yds versus 130,000 to 150,000 yds for the previous rope. **American Chain & Cable Co. Inc., CE 3-112, 929 Connecticut Ave., Bridgeport 2, Conn.**

For Accurate Plotting of Irregular Land

ENGINEERS OFTEN HAVE TO DEAL WITH IRREGULARLY SHAPED LAND AREAS, which are described in deeds by bearings and distances. A plotting accuracy of 0.1 ft at the usual scales can be attained for such irregularly shaped surveys through the use of a device called "Cemus-Emery Small Coordinatograph." The coordinato-

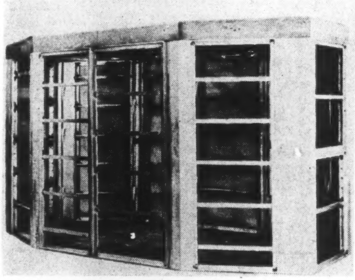


Coordinatograph

graph consists of two graduated metal rulers at right angles to each other. The rulers are graduated for three different scales (In photo, 1 in. equals 30, 40, 100 ft, respectively). First, the coordinates' differences must be computed. Departures are plotted with the large ruler; latitudes are plotted with the small ruler, which has a pricker attachment on one end. By means of a screw, the carriage is moved westward or eastward along the larger ruler until zero of the vernier for the small ruler matches the latitude of the point in question. A point is then marked with the pricker and so on with all the coordinates. Additional information about this precise instrument which is manufactured in Vienna, Europe, may be obtained from **Serge A. Emery, CE 3-112-113, 41 Shonnard Ave., Freeport, New York.**

For Pouring Concrete Manholes

RECENTLY BUILT ARE SPECIAL PANELS DESIGNED TO BE GROUPED IN AN OCTAGONAL SHAPE AND USED IN POURING CONCRETE MANHOLES. They consist of a magnesium frame, with a panel of plastic face plywood. The panels have no tie openings, but are cross braced for strength and are held together by connecting bolts and wedges. **Symons Clamp & Manufacturing Co., CE 3-113, 4249 Diversey Ave., Chicago, Illinois.**



Octagonal Shaped Panels

Safety Nets

LIFE NETS ARE ESSENTIAL FOR THE SAFETY OF WORKERS ON BRIDGES, DERRICKS, DAMS, BUILDINGS AND SIMILAR TYPES OF CONSTRUCTION. In addition to saving lives and catching falling equipment, they offer an important psychological benefit. Men, knowing that a Safety

(*Continued on page 114*)

Compacting sub-base on the Ohio Turnpike.

DO IT FASTER — BETTER and CHEAPER with the JACKSON VIBRATORY COMPACTOR!

MACADAM CONSTRUCTION: All around the country on major paving projects the JACKSON VIBRATORY COMPACTOR is being hailed as the most advantageous equipment ever developed for achieving specified density in rock, slag, soil-bound macadam, gravel and sand base courses. Uniform compaction to final density is obtained in rock macadam courses up to 12" in minimum time. The dry fines are quickly vibrated into all voids, filling them chockfull, solidly, from top to bottom of the course. Standard width is 13',3". Working speeds up to 60 FPM, reverse travel: 5½ MPH.

SUB-BASES, GRANULAR SOIL-CEMENT PAVING and SAND FILLS: It is equally efficient on gravel sub-bases and granular soil-cement paving or base course construction. And it's a bear-cat for compacting sand fills such as bridge approaches, since it quickly achieves desired density and individual units may be subtracted and even fitted with operating handles to suit every condition and to get into the really tight places.

PAVEMENT WIDENING: In any granular material used in flexible base course widening specified density is accomplished in one pass with the compacting units towed in tandem at the side of the tractor. Interchangeable bases from 12" to 26" wide may be substituted for standard 26" bases to suit requirements.

By all means investigate this time and money saving equipment

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for Concrete Paving

The average concrete paving job, whether it be an airport runway, a city street, or a state highway or turnpike, requires the use of four groups of Servicised Products. The first of these is **AIR ENTRAINING AGENT** added to the concrete at the mixer to produce a more durable concrete.

◀ ***Premolded Expansion Joint Fillers***

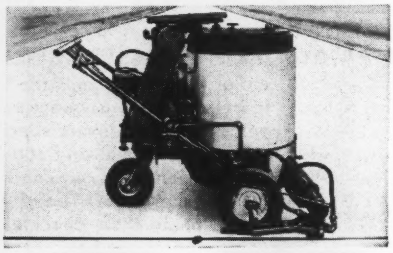
KORK-PAK — an exclusive Servicised development — is the all-purpose concrete paving joint filler. Composed of cork granules bonded together with asphalt between two sheets of heavy asphalt saturated paper. **KORK-PAK** is the *lowest cost non-extruding joint filler on the market.* **KORK-PAK** recovers more than 80% of original thickness after compression, and has a very low rate of moisture absorption. Available in ¼", ⅜", ½", ¾", and 1" thicknesses and standard lengths of 5 or 10 ft. Longer lengths available on special order. The Servicised premolded joint filler line also includes Asphalt, Cork, Self-Expanding Cork, and Sponge Rubber types, as well as Longitudinal Tongue and Groove Joint and premolded Dummy Contraction Joint.

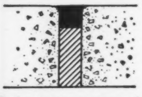
Joint Sealers ▶

Para-Plastic Hot-Poured Joint Sealer is an extremely stable rubberized asphalt compound that forms a resilient, adhesive and effective seal — keeping the joint completely protected under any and all conditions of temperature, moisture and traffic. Para-Plastic is pumped directly into the joint from the melting kettle.

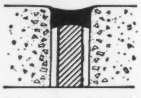
Para-Plastic JF for airport paving has the sealing characteristics of the standard compound, but in addition is impervious to solvents and jet fuel spillage.

SERVITITE Cold-Applied Joint Sealer is a bituminous rubber sealer so compounded that it can be pumped cold from the drum in which it is shipped directly into the joint to be sealed.

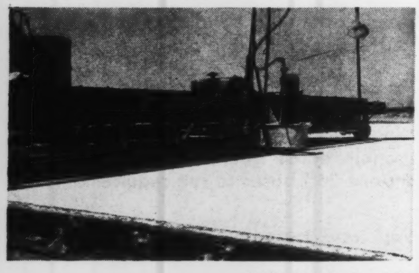




Joints compressed in warm weather temperatures



Joints opened in sub-zero temperatures



◀ ***Membrane Curing Compounds***

Available in two types—White Pigmented and Clear. Sprayed or painted on concrete, they form a uniform, moisture-retaining membrane to insure proper curing. Pigmented type reflects heat, reducing temperatures as much as 15°; Clear type, available with fugitive dye to assist in getting uniform coverage is used indoors or where natural color of the concrete must be retained.

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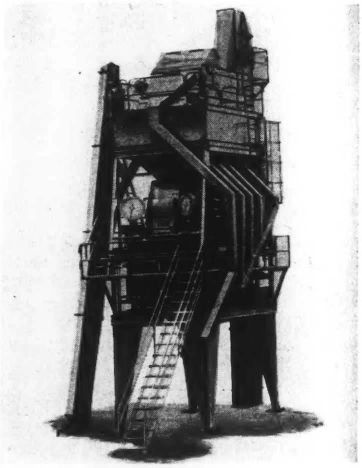
EQUIPMENT MATERIALS and METHODS

(continued)

Life Net is under them, are able to do their job with more confidence and greater efficiency. Newly designed life nets with safety L & S section clamps are now being manufactured. Nets are constructed of $^{3}/_{8}$ in. diameter extra superior, pure manila rope, with a breaking strength of 1,350 lbs. The rope is chemically treated to make it water-repellent and mildew-proof. Border lines on all sides are $^{3}/_{4}$ in. manila rope. Nets are available with 4, 6, 8 or 12 in. squares, and are made to individual specifications for each job. The patented L & S intersectional metal clamp strengthens the net and makes every junction fireproof and waterproof, and keeps the net from curling and knotting. Should the net be dragged along the ground when not in use, the metal clamps prevent the rope from wearing. **E. D. Bullard Co., CE 3-113-114, Industrial Safety Equipment, 275 Eighth St., San Francisco 3, Calif.**

Automatic Batch Plant

THE FIRST BITUMINOUS BATCH PLANT EVER DESIGNED FROM ITS ORIGINAL CONCEPTION, FOR AUTOMATIC OPERATION, HAS BEEN DEVELOPED. Seven basic objectives were established in planning the machine and were achieved in the final design. Briefly, these objectives, which have been incorporated into the batch plant, were: the elimination of the human element in achieving both accuracy and maximum



Bituminous Batch Plant

(*Continued on page 116*)

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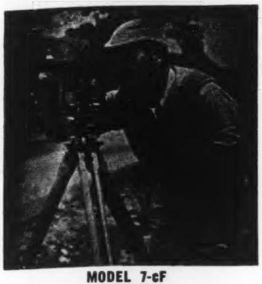

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- Sturdier construction for longer life.
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- Right angle peep right through telescope angle to save time.
- Non-cramping leveling head for ease of handling.
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The Edo Survey Depth Recorder, Model 255, was developed at the request of experts in the field of hydrographic survey. It is the finest equipment on the market for measuring the depth of water for survey purposes and for presenting in permanent form an accurate and legible record of the water's depth.

Accurate to within one-half of one per cent, the Survey Depth Recorder is designed in all respects to satisfy the most stringent requirements of cartographers, oceanographers, dredgers and all others concerned with the exact depth of the water in channels, harbors, inland or coastal waters.

The equipment is readily installed to operate aboard survey vessels of all types... traveling at any speed up to 15 knots... in any water depth from three feet to 250 fathoms... whether fresh, brackish or salt. Its light weight permits permanent or temporary installation on large or small survey craft.

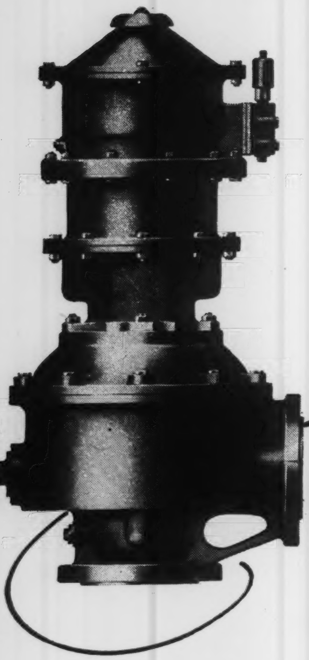
Precise Measurement in 8 Ranges

Edo Model 255 is easily adjustable for transducer draft or sound velocity and records in eight ranges:

0 to 70 feet or fathoms
60 to 130 feet or fathoms
120 to 190 feet or fathoms
180 to 250 feet or fathoms

Notes can easily be made on chart through large hinged window or positions marked automatically with marker button. One roll of paper operates 10 hours continuously on "foot" scale; 20 hours on "fathom" scale. Equipment is housed in rugged cast aluminum case. Send for brochure today.

Edo CORPORATION
College Point, L.I., N.Y. SINCE 1925



New Simplex Type CCAV *Valve. Combination controlled-closing and vacuum-breaking valve.*

ONE 4-INCH CONNECTION to your main pipe line...

PREVENTS { **surge rupture vacuum collapse**

Why take chances? No matter what the safety factor, surge and hammer can play some dirty tricks . . . rupture lines, blow out packing, fracture valves. And if the line breaks or is drained rapidly, it can collapse from vacuum.

Simplex Type CCAV is a new combination! A controlled-closing and vacuum-breaking valve to protect your lines against these dangers. It's easily installed, moderately priced, positive-acting.

When lines are being filled, Type CCAV Valve vents air to prevent binding, controls transfer time to prevent surge damage. Timing can be quickly set from a few seconds up to well over ten minutes—as dictated by site requirements. If hammer is excessive, Type CCAV automatically discharges water . . . extra protection for costly lines and fittings.

When lines are subject to collapse from rapid draining or line breaks, the Simplex CCAV acts quickly . . . breaks the vacuum for maximum safety.

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EQUIPMENT MATERIALS and METHODS

(continued)

capacity; convertibility from either automatic or manual operation; preset proportions for repetitive cycle operation; weighing by means of positive strike off of the aggregate, independent of relays operated by a moving scale pointer; a pugmill principle which takes advantage of a faster mixing cycle; automatic interruption of the cycle; and positive inspection of gradation and weight check. All sizes of aggregate, including the mineral filler, are weighed simultaneously. **Barber-Greene Company, CE 3-114-116, 400 North Highland Ave., Aurora, Illinois.**

Power Wheelbarrow

A MOTORIZED WHEELBARROW IS TAKING THE STRAIN OUT OF CONSTRUCTION JOBS requiring the use of wheelbarrows. Utilizing a 4-cycle, $2^1/_2$ horsepower motor mounted on supports behind the tray, this wheelbarrow, called the "Workhorse," can carry a full, 300-lb. load up a 16% grade. Throttle and clutch controls are located on the wheelbarrow handles, making starting and speed control a natural motion. Speed can be maintained at a walking pace. Semi-pneumatic drive wheels have a thick tractor tread which enables the wheelbarrow to ride and drive over irregular ground without trouble. For easier steering, a rear caster wheel permits the "Workhorse" to be spotted in position with a mere twist of the handles. Two drive-wheels directly under the load eliminates tipping. The 14 gauge steel tray is so balanced that dumping is a simple job. By pulling a catch and lifting lightly on a handle at the rear of the tray, the load is dumped effortlessly. **Worthington Mower Company, CE 3-116, Worthington Bldg., Stroudsburg, Pa.**

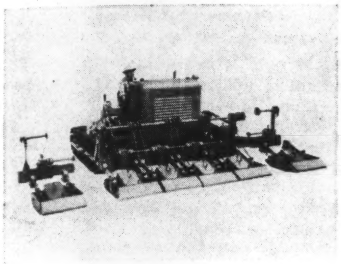
Motorized Wheelbarrow

EQUIPMENT MATERIALS and METHODS

(continued)

Vibro-Tamper

Crawler tracks spaced 8 ft apart instead of 12 ft for operation with either 4, 5 or 6 compaction shoes, the redesigned Model VT 6-4 Vibro-Tamper increases the machine's versatility for single-course base and sub-base compaction of both macadam and concrete roads and runways. Because of its efficient application of vibrating and tamping forces, an entire sub-base for a road or runway can be laid in one single-course, spread to a depth of 12 to 15 in. In one to two passes the Vibro-Tamper is said to compact the loose aggregate to approximately $^3/_4$ of its original volume to obtain the required Proctor. Savings by the vibrating method include the elimination of laying sub-bases in two or more unkeyed layers, involving stockpiling and material rehandling, as well as the extra labor required to compact the additional layers. In water-bound work, the Vibro-Tamper is said to "run in" screenings in as low as two passes, filling 75% of the voids on the first pass. This model, which employs six vibrating shoes to cover a full 13 ft 2 in. wide course, is converted to the 8 ft 6 in. width by removing one shoe from each side. **The International Vibration Company, CE 3-117, 16702 Waterloo Road, Cleveland 10, Ohio.**



Model VT 6-4

Glazed Concrete Block

The ceramic glazed concrete block, designated the Glasface, is now in commercial production for the first time. Representing the first time that a glassy finish has been successfully applied to an aggregate type concrete block without impairing the structural strength, the "Glasface" block will be available in a great number of colors, and can be used for the installation of the concrete block wall without requiring an additional finish. **The Ferro Corporation, CE 3-117, 4150 East 56th St., Cleveland, Ohio.**

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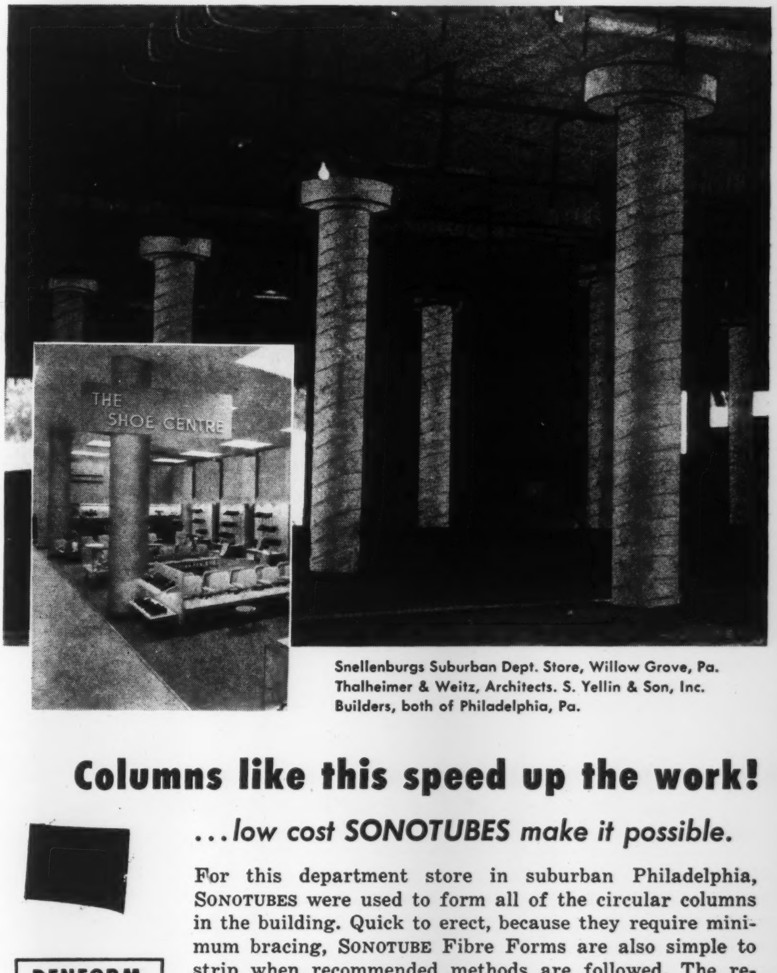
for round columns of concrete



Snellenburgs Suburban Dept. Store, Willow Grove, Pa.
Thalheimer & Weitz, Architects. S. Yellin & Son, Inc.
Builders, both of Philadelphia, Pa.

Columns like this speed up the work!

...low cost SONOTUBES make it possible.

For this department store in suburban Philadelphia, Sonotubes were used to form all of the circular columns in the building. Quick to erect, because they require minimum bracing, Sonotube Fibre Forms are also simple to strip when recommended methods are followed. The resulting concrete column is easy to finish because its smooth surface is unmarred.

Lightweight, low cost Sonotubes are proven to be a fast, economical method of forming round columns of concrete. Widely used and approved by contractors, engineers and architects everywhere.

Sonotubes are supplied in specified lengths up to 50′ or can be sawed to your requirements on the job. Sizes 1″ to 36″ I.D.

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BEFORE you buy, compare this White Dumpy level with a similar model of any other recognized make. From every standpoint — design detail . . . quality construction . . . work-speeding, life-lengthening features and cost — you'll quickly see why a White's the best buy you can make. It will make your work faster, easier, more accurate. Check this comparison chart:

FEATURES	D. White No. 7080	Instrument A	Instrument B
Magnifying power of telescope	35X	30X	27X
Distance away you can read 1/100 ft. graduation	1200 ft.	1050 ft.	900 ft.
Diameter of objective lens	1.81 in.	1.485 in.	1.69 in.
Field of view (in minutes of arc)	64′	52′	60′
Coated optics	YES	YES	YES
Covered leveling screws	YES	YES	YES
Can you easily replace worn leveling screws in the field?	YES	NO	YES
Sensitivity of level vial (in seconds of arc per 2mm of graduation)	20"	20"	25"
Price — complete with carrying case, tripod and accessories — F.O.B. factory	$295.00*	higher	higher

**Price subject to change without notice.*

For complete details on the 18-in. Dumpy level and other equally fine engineering instruments, see your David White dealer, or write direct to DAVID WHITE CO., 309 W. Court Street, Milwaukee 12, Wisconsin.

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We offer complete, expert repair service on all makes, all types of instruments

LITERATURE AVAILABLE

GALVANIZED ROOF DECK—A well-illustrated folder introduces the galvanized steel roof deck which will help meet the need for a structural deck that is competitive with poured-in-place decks. Construction time is cut because the total weight of this dry system, including insulation is less than three lbs per sq ft. Specifications for this galvanized roof deck are also given in the brochure. **Great Lakes Steel Corporation, Stran-Steel Division, CE 3-118, Detroit 29, Mich.**

PRE-MIXED MORTAR AND GROUT—Two illustrated folders explain that Embeco Pre-Mixed Mortar and Embeco Pre-Mixed Grout are superior to plain sand-cement mixes because they do not shrink upon hardening. Other advantages over plain sand-cement mixes include: higher compressive and impact-resistant strength, ductility or toughness, oil and water-resistance, and fast hardening. No assembling of ingredients is necessary. Complete directions for their use are given in the folders. **The Master Builders Co., CE 3-118, 7016 Euclid Ave., Cleveland 3, Ohio.**

CLEAN WATER—Designed to help civic leaders, municipal officials, and sewage treatment experts dramatize to their communities the urgency of the sewage problem is a two-color, 34 page bulletin entitled "Clean Water... And How To Get It." It contains facts on water pollution, a four-step course of community action to fight pollution, examples of successful municipal campaigns, and methods of maintaining public support for such programs. **General Electric Co., CE 3-118, Schenectady 5, N. Y.**

BRIDGE FLOORING AND THE DOWEL UNIT—A steel company has brought out two publications on the dowel unit and on bridge flooring which are illustrated with action photographs and specifications. Booklet 278-B, on the dowel unit, describes the use of this piece of road building equipment. It explains how it minimizes load transfer problems and how it keeps dowels aligned in concrete. The second folder, No. 599, gives data on formed steel bridge flooring. **Bethlehem Steel Company, CE 3-118, Bethlehem, Pa.**

DETACHABLE DITCHER—To illustrate the features of the Model CW-4 Detachable Ditcher, a 16 mm color and sound movie was produced by the Unimatic Corporation. The various job applications on which this Unimatic-Caterpillar combination can be used are also covered in the film. The movie takes ten minutes to play and may be obtained by contacting the **Unimatic Corporation, CE 3-118, P. O. Box 1166, Tulsa, Oklahoma.**

LITERATURE AVAILABLE
(Continued)

ENGINEERS' JOB DIRECTORY—This is a publication designed to help many of the nation's outstanding companies put their "story" before graduating engineers. EJD, the directory's abbreviated name, helps the engineer research the better job market. The 129 participating companies cooperate in presenting key facts in capsule form, giving precise information about their company, industry, year founded, products, number of employees and whom to contact. In the EJD index section, companies indicate the types of engineers they want and list the plant, sales, and research laboratory locations by cities and states. Another section lists the companies interested in undergraduates for summer jobs. Copies may be obtained for $2.25 from **Decision, Inc., CE 3-119, 105 E. Fourth St., Cincinnati 2, Ohio.**

PRESSURE MEASUREMENT AND CONTROL—The Exactel Manometer Follower, an instrument that might be the most accurate device for measurement of pressure, is described in a four page brochure. The manometer combines accuracies up to 0.001% of full scale by utilizing the liquid manometer and the modern servo instrument. The brochure provides a detailed description of the instrument with an explanation of its accuracy and the use of the servo-follower. **The Fanger Research Laboratory, CE 3-119, 15891 Santa Clara, Los Gatos Rd., Los Gatos, Calif.**

PRESTRESSED CONSTRUCTION—The Preload Company is offering a new 16-page pamphlet describing its Licensing Program for prestressed construction. The booklet tells how the company will grant freedom to use its design and construction methods for circular, linear, and area prestressing to the selected licensees. Seven categories of prestressed concrete construction, which the licensee may select, are presented and illustrated. For the pamphlet write to **The Preload Co., CE 3-119, 211 E. 37th St., New York 16, N.Y.**

ROOFING—A 20 minute, color, sound film called "A Case of Protection" has just been released. The new film tells the complete production story of asphalt roofing products and centers around a private investigator's solution to a case involving protection for his own home. His search for clues takes him to Certain-teed's plants and research and engineering laboratories where manufacturing quality control and research operation are filmed. Raw material sources, testing methods, shingle types and colors and the millerizing process are revealed in an animated sequence. The leading role is played by Frank Wilcox, well-known Hollywood actor. The film is available for showing to jobbers, dealers, roofing applicators, builders, contractors and the public. **Certain-teed Products Corporation, CE 3-119, Ardmore, Pennsylvania.**

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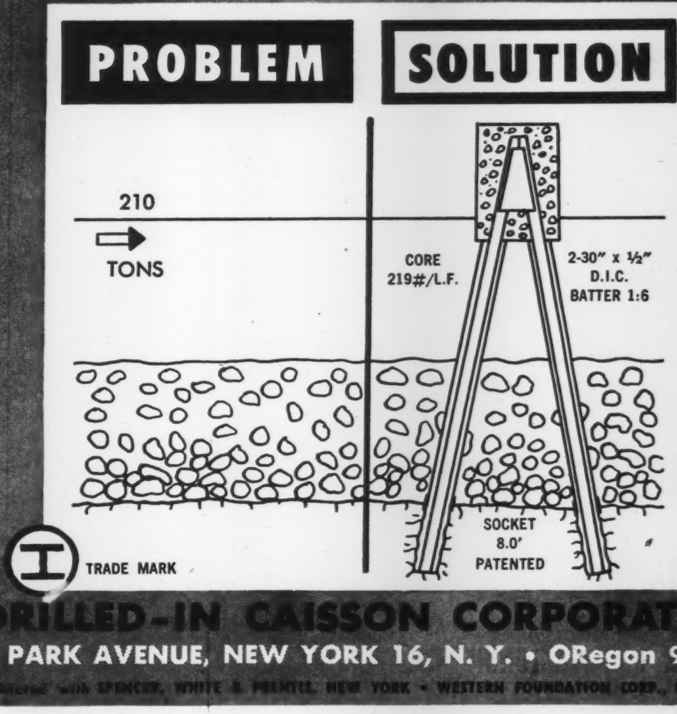

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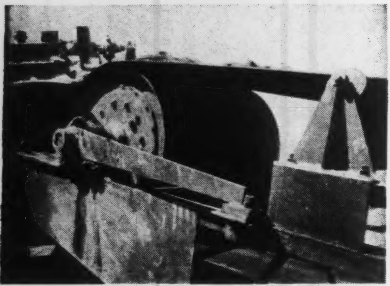

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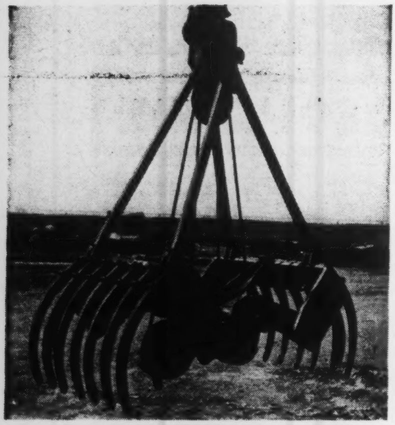

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From the MANUFACTURERS

Managements Consolidate Gardner-Denver and Keller Tool

Managements of the Gardner-Denver Company, Quincy, Illinois, and of the Keller Tool Company, Grand Haven, Michigan, have announced that the Stockholders of both Companies have approved a consolidation. Keller Tool Company now becomes the Keller Tool Division of Gardner-Denver Company and will continue operations under the former Keller management.

E. V. Erickson, President of Keller Tool Company has been elected an executive vice-president of Gardner-Denver Company; Gifford V. Leece remains as president of the Gardner-Denver Company.

Gardner-Denver Company, established in 1859, now manufactures a complete line of centrifugal and reciprocating pumps, portable and stationary air compressors, rock drills and mountings, air tools for contractors and plant maintenance, and other pneumatic equipment. The Keller Tool Division manufactures portable pneumatic tools for the automotive, aircraft, electronics, appliance and other industries.

Prestressed Concrete Institute Schedules April Meeting

The Prestressed Concrete Institute, a National Association of Prestressed Concrete Manufacturers, will hold its First Annual Meeting at the Lagamar Hotel, Fort Lauderdale, Florida, April 21 and 22.

The program will consist of a round table discussion of manufacturing problems, talks by authorities in the prestressing industry, and a field trip to the pretensioning plant of R. H. Wright & Son at Pompano Beach. An invitation is extended to the concrete industry, engineers and architects to attend this two day meeting. Further details may be obtained from Secretary, Prestressed Concrete Institute, Box 495, Lakeland, Florida.

Pittsburgh Corning to Expand

The Pittsburgh Corning Corporation has announced a 1½ Million Dollar Expansion Program scheduled for completion by mid-1955. As the first step in the program, production of the cellular glass insulation, Foamglas, will be increased by 25%. Plans include installation of a new production line at the company's Sedalia, Missouri plant and the construction of a 50,000 sq ft warehouse.

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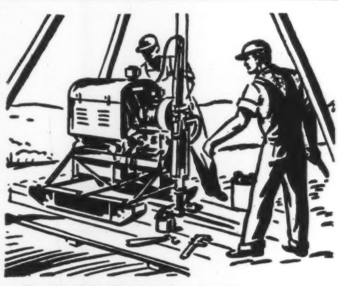

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From the MANUFACTURERS

(Continued)

H. K. Porter Buys Riverside Metal Co.

The Riverside Metal Co., Riverside, N.J., was purchased by H. K. Porter Company, Inc., on November 23rd, T. M. Evans, Porter's President announced. The acquisition of Riverside Metal Co. was arranged through the activities of Messrs. Edward Hopkinson of Drexel & Co. and B. F. Mechling, both directors of Riverside.

Riverside Metal is the fourth Division in the Porter group of manufacturing concerns acquired during 1954. The 100-year old concern manufactures non-ferrous metals in sheet, strip, rod, wire, bar and circle. Occupying 26 acres across the Delaware River from Philadelphia, the Riverside plant has 450,000 sq ft of factory space. The company has more than one thousand employees and in 1953 had sales in excess of thirteen million dollars.

Dorr, Oliver Merge

Effective date of the merger of The Dorr Company of Stamford, Connecticut and Oliver United Filters of Oakland, California under the name of Dorr-Oliver Incorporated was January 1, 1955. At that time personnel changes in the areas of Sales Promotion and of Public Relations went into effect.

C. W. Crumb, former Sales Promotion Manager for Oliver, took over the same position for the joint corporation. C. M. Comstock, Assistant Advertising Manager of Dorr, became Assistant Sales Promotion Manager for Dorr-Oliver. A. L. Morris, Advertising Manager for Dorr, assumed the responsibilities of Director of Public Relations for Dorr-Oliver and, in addition to the usual public relations functions, is responsible for product and technical publicity.

Headquarters of the new corporation are in Stamford, Connecticut.

Power Crane & Shovel Assn. Elects Walb President

Elected to the presidency of the Power Crane and Shovel Association at the association's annual meeting in Chicago was Walter W. Walb, president and general manager of the American Steel Dredge Co. Inc. Mr. Walb succeeds Julian Steelman, president of the Koehring Company, Milwaukee, Wisconsin. Mr. D. W. Lehti, president of the Link-Belt Speeder Corporation, was elected vice president of the association.

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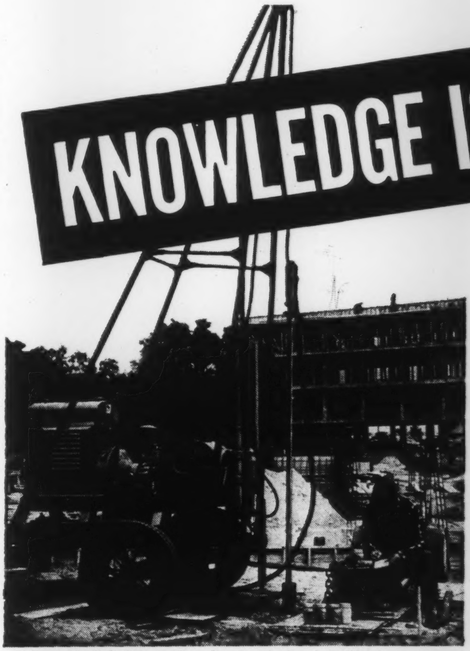

Acker Model TH Hydraulic Feed Core Drill mounted on two wheel trailer engaged in soil sampling and foundation test boring for a new building.

This Acker drill owned by a leading Southern University, is used not only for instructing engineering students, but commercial testing as well. In the latter capacity, it is in much demand by State governmental engineering departments for soil sampling and foundation test boring.

To see why Acker drills are preferred by leading engineers everywhere, write for Bulletin 30, CE.

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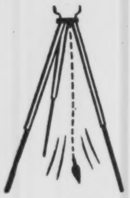
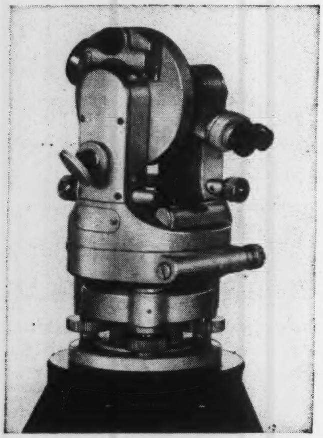
Has this been your problem? Now—old-type mechanical plumb-bob replaced by can't-miss optical principle





- Improved Theodolite reads horizontal and vertical circles simultaneously, through same eyepiece
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- Amazingly blur-free—small, compact, moisture-proof, dust-proof.

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From the MANUFACTURERS

(Continued)

The Wayne Crane Division of the American Steel Dredge Co. Inc. and fourteen other manufacturers of power cranes, shovels, trench hoes, industrial cranes and other earth-moving and materials handling equipment comprise the Power Crane and Shovel Association. Members of the association represent approximately 75% of the productive capacity of the shovel and crane industry.

Mr. Walb, who became associated with the American Steel Dredge Company in 1932, served as vice president of the Power Crane and Shovel Association during 1954.

G. E. to Power N.Y. Central's Harlem River Bridge

The New York Central Railroad's new twin-lift bridge spanning the Harlem River in New York City will be electrically powered and controlled by General Electric Company apparatus.

The bridge, scheduled for completion in 1956, actually consists of two, almost identical bridges side by side. Each will have a 340 ft movable span weighing 1400 tons, to carry two of the railroad's four passenger tracks. Each will also have its own 219 ft towers and lift machinery.

Powerful G-E mill type amplidyne-controlled direct current motors, connected to drive the huge sheaves at the top of the towers, will be able to raise the 1400 ton spans 135 ft above the water or lower them to the closed position in just 90 seconds. According to New York Central engineers, this is more than twice the speed of the operating swing bridge it replaces. The new span will serve New York Central mainline traffic from the Borough of Manhattan, replacing a swing span structure built in the late 1800's.

Am. Steel Band and Allegheny Steel Band have new Sales Manager

J. H. Bowman, Jr., has been appointed manager of sales for the affiliated companies: American Steel Band Company and Allegheny Steel Band Company. Although, for the past five years, Mr. Bowman has been sales manager for the latter firm only, he will now conduct an expanded national sales and advertising program for both manufacturers. His headquarters will be located at the combined main office and plant at Carnegie, Pa.

Products to be handled include American Steel Deck for roofing; asbestos protected metal roofing and siding; protected metal roof deck; insulated wall panels; cellular steel flooring, electrical; Asbo ventilators, louvres, ducts and skylights; and steel strapping and accessories.

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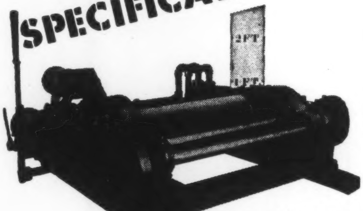

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PROCEEDINGS AVAILABLE

The following papers have become available as Proceedings-Separates. Following the date of issue of a paper, discussions thereof will be received for a period of three months, as specified on the cover of the paper. Titles will be added to this list every month, as they become available. Technical Division sponsorship is indicated by an abbreviation at the end of each item, the symbols referring to: Air Transport (AT), City Planning (CP), Construction (CO), Engineering Mechanics (EM), Highway (HW), Hydraulics (HY), Irrigation and Drainage (IR), Power (PO), Sanitary Engineering (SA), Soil Mechanics and Foundations (SM), Structural (ST), Surveying and Mapping (SU), and Waterways (WW) divisions. Papers issued prior to, and including, Separate No. 289, were not distributed under the present automatic mailing system. If you have not registered in a Technical Division to receive its papers (one Division only) free of charge, please do so promptly by filling out and mailing the enrollment and subscription form (page 125) to Society Headquarters. For ordering separate papers, use the convenient order form on page 124.

February

608. Canal and Locks at Chain of Rocks, Mississippi River, by A. F. Griffin. (WW) The paper describes the general plan and pertinent details of the locks and canal which by-pass the Chain of Rocks reach of the Mississippi River near St. Louis, Mo. The improvement covers a length of approximately 8 miles and consists of a canal with a bottom width of 300 ft, a barge turning basin and harbor, a main lock, 1,200 ft by 110 ft, and a standard auxiliary lock.

609. Shale Foundations for Earth Dams, by Delbert B. Freeman. (WW) Shale is discussed as a foundation material for earth dams and appurtenant structures, with a description of the causes for failure of dams on poor foundations and an insistence on the need for geologic investigations and laboratory tests of the material to determine design factors.

610. Channel Depths for Modern Ports, by B. B. Talley. (WW) Primary considerations in determining depths to be provided in a modern harbor are the drafts of the vessels expected to use the port, the customary trim or loading of ships, the "squat" or "sinkage" of vessels in motion under their own power, the nature of the material in which a channel lies, and the clearance under keels. The trend in design respecting draft is indicated by data on typical vessels of various classes constructed during the 20th century.

611. Graphic Design of Alluvial Channels, by Ning Chien. (WW) Channel depth and slope to carry a given unit discharge and sediment load are determined graphically on the basis of the Einstein bed-load function. Applications of these curves are made to evaluate the effects on river regimen by the diversion of flows, construction of dams, contraction of channels, elimination of river forks, and cut-off of bends.

612. River Surveys in Unmapped Territory, by Gerard H. Matthes. (WW) To assist engineers concerned with river utilization problems in areas which are unmapped and for which streamflow data are lacking, there are presented short-cut methods adapted to exploratory or reconnaissance surveys and methods of providing both reliable surveys of specific local areas and more extensive maps.

613. Scale Model of the Suez Canal, by Paul Blanquet. (WW) The author describes and analyzes hydraulic model studies which relate size and shape of the waterway and speed of transit of the ship to hydraulic phenomena and bank erosion. They indicate that increased speed and decreased waterway area result in increased erosion whereas the slope of the banks is less important.

614. Port of Lake Charles, La., by Elmer E. Shutts. (WW) The port of Lake Charles is the result of the independent effort of a small community to establish its own deep water shipping facilities. From the inception of the project to date there has been a continuous growth in shipping from 45,000 tons in 1926 to approximately 16,000,000 tons in 1953.

615. Modern Design of General Cargo Marine Terminals, by Frank W. Herring. (WW) The design of a modern marine terminal is discussed through analysis of its functions, basic form, and factors governing design. Standards developed by the Port of New York Authority are included, and reference is made to two modern facilities in the harbors of New York and San Francisco.

616. Beach Rehabilitation by Fill and Nourishment, by J. V. Hall, Jr. and George M. Watts. (WW) Beach erosion problems resulting from the progressive development of resorts and the construction of navigable inlets have been combatted by various methods of artificial nourishment using beach fills. This procedure aims to provide a sufficient amount of material to supply continuously the downdrift areas with replacement fill to make up for losses due to erosion.

617. Hydraulic Design of Pump Station 5A, Central and Southern Florida Project, by Edwin W. Eden, Jr. (IR) Pump station 5A is a unit of the Central and Southern Florida project which, after construction, will provide water control for West Palm Beach Canal within the Lake Okeechobee agricultural area. Determination of pump-station characteristics required for satisfactory water control is presented together with results of studies to determine operating characteristics.

618. Pumping Ground Water for Irrigation and Drainage, by Cleve H. Milligan. (IR) Ground water is an important but neglected national resource. Its utilization produces both irrigation and drainage benefits. Physical data, legal concepts, and administrative principles and practices must be

INSTRUCTIONS

1. Every ASCE member registered in one of the Technical Divisions will receive free and automatically all papers sponsored by that Division. **Such registration will be effective the first of the month following the receipt of the registration form.**

2. In addition to those papers sponsored by the Division in which he is registered, a member is entitled to 100 different papers during a fiscal year.

3. Members' accounts will be charged 25¢ each for additional duplicate copies of a paper and for papers in excess of his free allotment.

4. Papers should be ordered by serial number. The member should keep a record of Separates ordered to avoid unwanted duplication.

5. Non-members of the Society may order copies of Proceedings papers by letter with remittance of 50¢ per copy; members of Student Chapters, 25¢ per copy.

Standing orders for all Separates in any calendar year may be entered at the following annual rates: Members of ASCE, $12.00; members of Student Chapters, $12.00; non-members, $20.00, plus foreign postage charge of $0.75; libraries, $10.00.

TRANSACTIONS. Specially selected PROCEEDINGS papers with discussions will be included in TRANSACTIONS. Annual volumes of TRANSACTIONS will continue to be available at the current established annual subscription rates.

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improved and developed to stimulate and guide sound ground-water development.

619. Ground Water and Drainage Problems of the Weber Basin Project, Utah, by F. M. Warnick and William H. Greenhalgh. (IR) Control of leakage from confined ground-water basins and disposal of seepage from irrigation are important on the Weber Basin Project because the feasibility of the irrigation development depends on the successful reclamation of lands plagued with a high water table. The paper discusses the problems and outlines the investigations performed to develop a sound drainage plan.

620. A Concept of Lacey's Regime Theory, by Ning Chien. (IR) Lacey's regime theory is analyzed on the basis of the Einstein bed-load function. It has been found that the "silt" factor f_{VR} depends on the sediment concentration of the channel flow whereas f_{RS} is a function of the bed material size. Using these functional relationships between sediment characteristics and Lacey's "silt" factors, the depth and slope of an alluvial channel in regime can be determined by the Einstein bed-load function or by Lacey's regime theory.

621. Discussion of Proceedings-Separates 347, 404, 426, 461, 462. (IR)

622. Use and Economy of Concrete Pipe in Irrigation Systems, by A. B. Reeves. (IR) The economy in the use of concrete pipe in irrigation systems is considered in relation to saving of water, reduced cost of operation and maintenance, value of right of way, and reduction of seeped areas caused by losses through pervious canal sections. Uses for concrete pipe are divided into three categories—structures, supply lines, and distribution systems.

623. Operation and Maintenance of Irrigation Systems, by Floyd M. Roush. (IR) There is a tendency quite often among water-user organizations to neglect or defer maintenance on irrigation facilities. This paper points out that the key to a successful irrigation enterprise is keeping all maintenance work current. Other factors essential for good operation are an organization of qualified personnel, good public relations with the water users, selection and maintenance of equipment, conserving the water supply, and protecting the irrigated land from seepage.

624. Discussion of Proceedings-Separates 361, 381, 466, 482, 483, 490. (HY)

625. Investigating Ground Water by Applied Geophysics, by David K. Todd. (HY) Geophysical methods for petroleum and mineral exploration may be adapted for ground-water location, analysis, and development. Brief summaries of particularly useful geophysical approaches are presented. Basic principles, methods, applications, and examples are included. A selective bibliography concludes the paper.

626. Discharge Coefficients for Spillways at TVA Dams, by Kenneth W. Kirkpatrick. (HY) Spillway discharge coefficients from model studies for eleven TVA dams are presented. Coefficients for both submerged and free discharge conditions are presented for discharges over standard and irregular spillway crests and a vertical lift spillway gate.

627. Modern Methods of Developing Ground-Water Supplies, by R. M. Leggette. (HY) Preliminary considerations in choosing an area for ground-water development are outlined. Methods and procedures used in prospecting for and developing ground-water resources are discussed. The author offers suggestions for desirable observation and maintenance programs after a ground-water development is in operation.

628. Ground-Water Flow in Relation to a Flooding Stream, by David K. Todd. (HY) Quantitative data on ground-water flow during storm runoff periods are scarce. This study presents some information on the time distribution and magnitude of such flows based on model measurements. Results of the model analogy are interpreted in terms of bank storage volume and distribution, and magnitude and time distribution of ground-water flow.

629. Streamflow Reactions of a Fire-Damaged Watershed, by J. D. Sinclair and E. L. Hamilton. (HY) Records of rainfall and stream-flow from the partly burned watershed in the San Gabriel Mountains of southern California and from a comparable unburned drainage, before and after the December, 1953, fire were analyzed. The analyses showed that peak flows and storm discharges from the damaged watershed were greatly increased by the effects of the fire.

630. Flood Frequencies Derived from River Forecasting Procedures, by Ralph F. Kresge and Tor J. Nordenson. (HY) The engineer who designs drainage structures must estimate the peak annual discharge expected for some selected return period or periods. Such estimates are often based on frequency analyses or relatively short discharge records and therefore have questionable reliability. In the study reported, the record of peak annual discharge values was extended through use of precipitation data and a river-forecasting procedure. The differences between the frequency curves based on observed and estimated flood peaks were small and were far less than the differences between frequency curves developed from segments of the observed record.

631. Beach Protection Creates Legal Problems, by Morris N. Lipp. (HY) The paper describes the engineering studies involved in the defense of a lawsuit. The plaintiffs complained that bulkheads were permitted to encroach on the public ocean foreshore, and the defense contended the area had been subject to avulsions and that, therefore, the upland owners had a right to reclaim lost land.

632. Structural Success or Failure? by Jacob Feld. (CO) Some typical examples of structural distress and its cause and correction are described. Avoidance of such distress is rather simple and inexpensive; correction is usually complicated, time-consuming, and costly both in money and reputation. Valuable lessons can be learned from impartial description of structural failures.

633. Scope of Pipeline Transportation in the United States, by Eldon V. Hunt. (CO) Pipelines for crude oil, petroleum products, or natural gas in the United States extend over 594 thousand miles. One eighth of all ton-miles of freight move through these lines, and natural gas heats more homes than any other fuel. Pipelines are advantageous because delivery is constant, packaging is not required, and the systems are free from surface maintenance.

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